KANNUR UNIVERSITY

കണ്ണൂർസർവ്വകലാശാല

Re-accredited by NAAC with 'B++' Grade

KUFYUGP

B.Sc. PHYSICS HONOURS

CURRICULUM & SYLLABUS

Effective from 2025 Admission Onwards

www.kannuruniversity.com

Contents

PREFACE

The undergraduate program in Physics leading to a Bachelor of Science (B.Sc.) in Physics Honours or B.Sc. in Physics Honours with Research is designed to cultivate a profound understanding of the fundamental principles governing the natural world. This comprehensive four-year curriculum is tailored to nurture inquisitive minds, fostering a deep-seated appreciation for both the theoretical and experimental facets of physics.

The curriculum spans over four years, divided into eight semesters. Each semester is carefully crafted to build upon the knowledge acquired in the previous ones, creating a coherent and cumulative learning experience. The discipline specific courses cover essential topics such as Classical Mechanics, Electromagnetism, Thermodynamics, Quantum Mechanics, Statistical Physics, and Modern Physics. Advanced topics in specialized areas such as Condensed Matter Physics, Nuclear Physics, Astrophysics, and Particle Physics is also included, catering to students' diverse interests and career aspirations.

The BSc Physics Honours program emphasizes a strong theoretical foundation complemented by extensive laboratory experience. Students will engage in hands-on experiments that reinforce classroom learning and develop critical technical skills. Through practical work, they will learn to design experiments, utilize sophisticated instruments, and analyse data, thus bridging the gap between theory and practice.

For those opting for the BSc Physics Honours with Research track, the program offers an enriched experience with a significant focus on independent research. This track is designed for students who wish to delve deeper into specific areas of interest, culminating in a research thesis. Under the mentorship of faculty members, students will undertake original research projects, honing their ability to conduct scientific inquiries, think critically, and contribute to the body of knowledge in physics. This rigorous training prepares graduates for careers in academia, research institutions, and industry.

In an era where technological advancements and scientific discoveries are pivotal to societal progress, a degree in physics equips students with problem-solving abilities, analytical skills, and a methodical approach to addressing complex challenges. Whether you aspire to unravel the mysteries of the cosmos, develop cutting-edge technologies, or contribute to interdisciplinary scientific endeavours, the BSc Physics Honours and BSc Physics Honours with Research programs provide a solid foundation for a rewarding and impactful career.

We are delighted to present the revised curriculum and syllabus for the four-year UG Physics Programme of affiliated colleges of Kannur University, which will be effective from the 2024 academic year onwards.

The successful revision of this curriculum would not have been possible without the collective efforts and inputs from the BOS members, Ad hoc committee members, Physics academic council member, resource persons and the unwavering support of Physics faculty members from the affiliated colleges. Their dedication and expertise have played an instrumental role in shaping a curriculum that is relevant, up-to-date, and consistent with international scholarly criteria.

We welcome all students embarking on this exciting journey and look forward to their future achievements in the field of physics.

Dr. Lisha Damodaran
Chairperson
Board of Studies (UG), Physics
Kannur University

INTRODUCTION

Kannur University - Four-Year Undergraduate Programme: Backdrop and Context

The implementation of the Four-Year Undergraduate Programme (FYUGP) has been driven by the pressing need to address contemporary challenges ensuring responsive changes to the evolving needs of students, industry, and society at large. Recognizing the curriculum as the cornerstone of any education system, it requires regular refinement to align with evolving socio-economic factors. Higher education must provide students with practical and technical skills relevant to their fields of interest, necessitating the development of a job-oriented curriculum. Despite significant increases in access and expansion of higher education over the years, concerns persist regarding the quality and relevance of educational outcomes, particularly in terms of employability skills. As the world becomes increasingly interconnected, our education system must evolve to instil 21st-century skills, enabling students not only to survive but to thrive in this dynamic environment. Moreover, there is a growing need for higher education institutions to embrace social responsibility and contribute to the development of a knowledge society capable of driving sustainable development through innovation. With the central objective of fostering a robust knowledge society to support a knowledge economy, the Government of Kerala has initiated steps to reform higher education. Accordingly, three commissions were established to suggest reforms in higher education policy, legal and regulatory mechanisms, and evaluation and examination systems. It is within this context that a comprehensive reform of the undergraduate curriculum has been proposed, leading to the restructuring of the Four-Year Undergraduate Programme (FYUGP).

VISION AND MISSION OF KANNUR UNIVERSITY

Vision:

To establish a teaching, residential and affiliating University and to provide equitable and just access to quality higher education involving the generation, dissemination and a critical application of knowledge with special focus on the development of higher education in Kasargod and Kannur Revenue Districts and the Manandavady Taluk of Wayanad Revenue District.

Mission:

- To produce and disseminate new knowledge and to find novel avenues for application of such knowledge.
- To adopt critical pedagogic practices which uphold scientific temper, the uncompromised spirit of enquiry and the right to dissent.
- To uphold democratic, multicultural, secular, environmental and gender sensitive values as the foundational principles of higher education and to cater to the modern notions of equity, social justice, and merit in all educational endeavours.
- To affiliate colleges and other institutions of higher learning and to monitor academic, ethical, administrative, and infrastructural standards in such institutions.
- To build stronger community networks based on the values and principles of higher education and to ensure the region's intellectual integration with national vision and international standards.
- To associate with the local self-governing bodies and other statutory as well as non-governmental organizations for continuing education and also for building public awareness on important social, cultural and other policy issues.

PROGRAM OUTCOMES (POs)

Program Outcomes (POs) serve as a foundational framework defining the skills, knowledge, and attributes that students at Kannur University are expected to acquire upon completion of a specific academic program. Tailored to the unique goals of each program, POs articulate the overarching learning objectives that guide curriculum design and assessment. These outcomes encompass a diverse range of competencies, including critical thinking, problem-solving, effective communication, and discipline-specific expertise. POs play a crucial role in shaping educational experiences, ensuring alignment with academic standards and industry expectations. By articulating clear and measurable expectations, POs contribute to the continuous improvement of academic programs and provide a roadmap for students to develop into well-rounded, competent professionals within their chosen fields.

PO1: Critical Thinking and Problem-Solving-Apply critical thinking skills to analyse information and develop effective problem-solving strategies for tackling complex challenges.

PO2: Effective Communication and Social Interaction-Proficiently express ideas and engage in collaborative practices, fostering effective interpersonal connections.

PO3: Holistic Understanding-Demonstrate a multidisciplinary approach by integrating knowledge across various domains for a comprehensive understanding of complex issues.

PO4: Citizenship and Leadership-Exhibit a sense of responsibility, actively contribute to the community, and showcase leadership qualities to shape a just and inclusive society.

PO5: Global Perspective-Develop a broad awareness of global issues and an understanding of diverse perspectives, preparing for active participation in a globalized world.

PO6: Ethics, Integrity and Environmental Sustainability-Uphold high ethical standards in academic and professional endeavours, demonstrating integrity and ethical decision-making. Also acquire an understanding of environmental issues and sustainable practices, promoting responsibility towards ecological well-being.

PO7: Lifelong Learning and Adaptability-Cultivate a commitment to continuous self-directed learning, adapting to evolving challenges, and acquiring knowledge throughout life.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO1. **Comprehensive Knowledge in Core Physics Concepts**:

Graduates will demonstrate a thorough understanding of fundamental physics principles, including Mechanics, Electromagnetism, Thermodynamics, Quantum Mechanics, and Statistical Physics. This knowledge will form the basis for solving complex problems and conducting research in Physics.

PSO2. Proficiency in Mathematical and Computational Techniques:

Graduates will be skilled in applying advanced mathematical methods and computational tools to model and solve physical problems. They will be proficient in using software and programming languages relevant to physics, such as MATLAB, Python, and others.

PSO3. Experimental and Laboratory Skills:

Graduates will possess strong experimental skills, including the ability to design, conduct, and analyse experiments. They will be adept at using modern laboratory equipment and techniques, and will understand the principles of measurement, data acquisition, and error analysis.

PSO4. Research and Analytical Skills:

Graduates will be capable of conducting independent research, including formulating hypotheses, designing experiments or theoretical models, analysing data, and interpreting results. They will be able to critically evaluate scientific literature and present their findings in both written and oral formats.

PSO5. Problem-Solving and Critical Thinking:

Graduates will demonstrate strong problem-solving abilities and critical thinking skills. They will be able to approach complex physical problems systematically, identify the relevant principles and techniques required, and develop effective solutions.

PSO6. Communication and Collaboration:

Graduates will be effective communicators, able to convey complex physical concepts clearly and concisely to diverse audiences. They will also possess teamwork and collaboration skills, enabling them to work effectively in multidisciplinary and multicultural teams.

PSO7. Ethics and Professionalism:

Graduates will understand the ethical implications of scientific work and will adhere to high standards of scientific integrity and professionalism. They will be aware of the societal impact of physics and technology, and will be prepared to contribute responsibly to scientific and technological advancements.

These outcomes ensure that graduates not only have a strong foundation in physics but also the skills necessary to apply their knowledge in various professional and academic settings.

STRUCTURE OF THE PROGRAMME

The Programme of instruction will consist of Lecture courses, Practical courses, comprehensive Viva-voce, Seminar, internship/ industrial visit, and Project work.

1. Lecture courses**:** Courses involving lectures relating to a field or discipline by a faculty member

2. *Tutorial courses*: Courses involving problem-solving and discussions relating to a field or discipline under the guidance of qualified personnel in a field of learning,

3. *Laboratory work*: A course requiring students to participate in a project or practical or lab activity that applies previously learned/studied principles/theory related to the chosen field of learning, work/vocation, or professional practice under the supervision of an instructor.

4. Comprehensive Viva-voce :This is an essential assessment included in the Programme to evaluate the student's grasp of the subject matter and their ability to apply their knowledge as defined in the course outcomes. It also provides an opportunity for the student to engage in academic discussions and receive valuable feedback from experts in the field.

4. *Seminar:* A course requiring students to participate in structured discussion/conversation or debate focused on assigned tasks/readings, current or historical events, or shared experiences guided or led by an expert or qualified personnel in a field of learning

5. Internship/ Institutional visit : All students shall undergo a Field Trip/Summer Internship/Apprenticeship in a Firm, Industry or Organization; or Training in labs with faculty and researchers or other Higher Education Institutions (HEIs) or research institutions. Departments can actively promote internships that can eventually lead to research project work. Institutional visit Incorporating institutional or industrial visits in the Programme brings immense value to the students, making their learning journey more enriching and preparing them for successful careers in physics-related fields.

6. Research Project: These students who have opted for the honours with research should complete a research project under the guidance of the mentor and should submit a research report for evaluation. They need to successfully defend the research project to obtain 12 credits under a faculty member of the University/College. The research shall be in the Major discipline

COURSE STRUCTURE

Course and Credit Structure for Different Pathways

Course Distribution for Students in Semesters I – VI

(1) ***Single Major***: The 6 courses together in B and C can be in different disciplines.

(2) ***Major with Multiple Disciplines***: B and C represent two different disciplines.

(3) ***Major with Minor***: B and C represent the same Minor discipline.

I SEMESTER				
Sl No	**Course**	**Hours/Week**	**Credits**	**Total Marks**
1	AEC1 (English)	4	3	75
2	AEC2 (Additional Language)	3	3	75
3	MDC1	3	3	75
4	DSC A1	5	4	100
5	DSC B1	4/5	4	100
6	DSC C1	4/5	4	100
	Total	**23/25**	**21**	**525**

II SEMESTER				
Sl No.	**Course**	**Hours/Week**	**Credits**	**Total Marks**
1	AEC3 (English)	4	3	75
2	AEC4 (Additional Language)	3	3	75
3	MDC2	3	3	75
4	DSC A2	5	4	100
5	DSC B2	4/5	4	100
6	DSC C2	4/5	4	100
	Total	**23/25**	**21**	**525**

III SEMESTER				
Sl No.	**Course**	**Hours/Week**	**Credits**	**Total Marks**
1	MDC3 (Kerala Studies)	3	3	75
2	VAC1	3	3	75
3	DSC A3	4	4	100
4	DSC A4	5	4	100
5	DSC B3	4/5	4	100
6	DSC C3	4/5	4	100
	Total	**23/25**	**22**	**550**

IV SEMESTER				
Sl No.	**Course**	**Hours/Week**	**Credits**	**Total Marks**
1	SEC1	3/4	3	75
2	VAC2	3/4	3	75
3	VAC3	3/4	3	75
4	DSC A5	5	4	100
5	DSC A6	5	4	100
6	DSC A7	5	4	100
	Total	**24/25**	**21**	**550**

V SEMESTER				
Sl No.	**Course**	**Hours/Week**	**Credits**	**Total Marks**
1	SEC2	3	3	75
2	DSC A8	5	4	100
3	DSC A9	4	4	100
4	DSC A10	5	4	100
5	DSE A11	4	4	100
6	DSE A12	4	4	100
	Total	**25**	**23**	**575**

VI SEMESTER				
Sl No.	**Course**	**Hours/Week**	**Credits**	**Total Marks**
1	SEC3	3	3	75
2	DSC A13	5	4	100
3	DSC A14	5	4	100
4	DSC A15	4	4	100
5	DSE A16	4	4	100
6	DSE A17	4	4	100
7	Internship		2	50
	Total	**25**	**23**	**625**

***4) Double major pathway**:* A and B represent the courses offered by the two departments. Students should choose one of the disciplines as their major 1 and the other as major 2

I SEMESTER				
Sl No.	**Course**	**Hours/Week**	**Credits**	**Total Marks**
1	AEC1 (English)	4	3	75
2	AEC2 (Additional Language)	3	3	75
3	MDC A/B	3	3	75
4	DSC A1	5	4	100
5	DSC A2	5	4	100
6	DSC B1	4/5	4	100
	Total	**24/25**	**21**	**525**

II SEMESTER				
Sl No.	**Course**	**Hours/Week**	**Credits**	**Total Marks**
1	AEC2 (English)	4	3	75
2	AEC3 (Additional Language)	3	3	75
3	MDC A/B	3	3	75
4	DSC A3	5	4	100
5	DSC B2	4/5	4	100
6	DSC B3	4/5	4	100
	Total	**23/25**	**21**	**525**

III SEMESTER				
Sl No.	**Course**	**Hours/Week**	**Credits**	**Total Marks**
1	MDC A/B	3	3	75
2	VAC A/B	3	3	75
3	DSC A4	4	4	100
4	DSC A5	5	4	100
5	DSC B4	4/5	4	100
6	DSC B5	4/5	4	100
	Total	**23/25**	**22**	**550**

IV SEMESTER				
Sl No.	**Course**	**Hours/Week**	**Credits**	**Total Marks**
1	SEC A/B	3	3	75
2	VAC A/B	3	3	75
3	VAC A/B	3	3	75
4	DSC A6	5	4	100
5	DSC A7	5	4	100
6	DSC B6	4/ 5	4	100
	Total	**24/25**	**21**	**550**

V SEMESTER				
Sl No.	**Course**	**Hours/Week**	**Credits**	**Total Marks**
1	SEC A/B	3	3	75
2	DSC A8	4/5	4	100
3	DSC A9	4/5	4	100
4	DSE A10	4/5	4	100
5	DSC B7	4/5	4	100
6	DSE B8	4/5	4	100
	Total	**23/25**	**23**	**575**

VI SEMESTER				
Sl No.	**Course**	**Hours/Week**	**Credits**	**Total Marks**
1	SEC A/B	3	3	75
2	DSC A11	4/5	4	100
3	DSE A12	4/5	4	100
4	DSC B9	4/5	4	100
5	DSC B10	4/5	4	100
6	DSE B11	4/5	4	100
7	Internship		2	50
	Total	**23/25**	**23**	**625**
On completion of 3-year UG Student will get 68 credits in major A (48 + 18+2 = 68 (50% of 133)) and 53 credits in Major B (44 + 9 = 53 (40% of 133))				

STUDENT CAN EXIT WITH UG DEGREE / PROCEED TO FOURTH YEAR WITH MINIMUM 133 CREDITS.

VII SEMESTER				
Sl No.	**Course**	**Hours/Week**	**Credits**	**Total Marks**
1	DSC A1	4/5	4	100
2	DSC A2	4/5	4	100
3	DSC A3	4/5	4	100
4	DSC A4	4/5	4	100
5	DSC A5	4/5	4	100
	Total	**20/25**	**20**	**500**

<table>
<tr><th colspan="6">VIII SEMESTER</th></tr>
<tr><th>Sl No.</th><th colspan="2">Course</th><th>Hours/Week</th><th>Credits</th><th>Total Marks</th></tr>
<tr><td>1</td><td colspan="2">DSC A6</td><td>4</td><td>4</td><td>75</td></tr>
<tr><td>2</td><td colspan="2">DSC A7</td><td>4</td><td>4</td><td>100</td></tr>
<tr><td>3</td><td colspan="2">DSC A8</td><td>4</td><td>4</td><td>100</td></tr>
<tr><td colspan="6">OR</td></tr>
<tr><td>4</td><td colspan="2">KU8RPHPHY401 (Project for Honours with Research)</td><td></td><td>12</td><td>300</td></tr>
<tr><td colspan="6">OR</td></tr>
<tr><td>5</td><td colspan="2">KU8CIPPHY402(Project for Honours)</td><td></td><td>8</td><td>200</td></tr>
<tr><td>6</td><td colspan="2">Any one DSC from A6-A8</td><td>4</td><td>4</td><td>100</td></tr>
<tr><td colspan="6">OR</td></tr>
<tr><td>7</td><td colspan="2">KU8CIPPHY403(Project for Honours)</td><td></td><td>12</td><td>300</td></tr>
<tr><td></td><td colspan="2">Total</td><td></td><td>12</td><td>300</td></tr>
<tr><td colspan="6">ELECTIVES: Three elective courses are compulsory for Honours and Honours with Research Programmes. For Honours with research Programme one must be KU8DSEPHY401.</td></tr>
<tr><td>8</td><td colspan="2">DSE A1</td><td>4</td><td>4</td><td>100</td></tr>
<tr><td>9</td><td colspan="2">DSE A2</td><td>4</td><td>4</td><td>100</td></tr>
<tr><td>10</td><td colspan="2">DSE A3</td><td>4</td><td>4</td><td>100</td></tr>
<tr><td colspan="6">OR</td></tr>
<tr><td>11</td><td>DSC B1</td><td rowspan="3">From any discipline/ any three disciplines</td><td></td><td>4</td><td>100</td></tr>
<tr><td>12</td><td>DSC B2</td><td></td><td>4</td><td>100</td></tr>
<tr><td>13</td><td>DSC B3</td><td></td><td>4</td><td>100</td></tr>
<tr><td></td><td colspan="5">Two of these courses can be in the online mode. These online courses can be taken either in semester VII or in semester VIII, but their credits shall be added to the student’s account only in semester VIII. For those students who go to another institution for doing the Project, all these three courses can be in the online mode or in the in-person mode from the institution where the Project is being done.</td></tr>
<tr><td></td><td colspan="2">Total</td><td>12</td><td>12</td><td>300</td></tr>
</table>

PHYSICS COURSE DETAILS

SEMESTER	COURSE CODE	COURSE NAME	CREDITS Lecture + Tutorial	Practical	TOTAL	HOURS/WEEK	MARKS
GENERAL FOUNDATION COURSES							
	MDC						
I	KU1MDCPHY101	Physics Around Us	3	0	3	3	75
II	KU2MDCPHY102	Wonders of the Cosmos	3	0	3	3	75
	VAC						
III	KU3VACPHY101	Radiation Hazards and Protection	3	0	3	3	75
IV	KU4VACPHY102	Green Energy for Sustainability	3	0	3	3	75
	KU4VACPHY103	Scientific Ethics	3	0	3	3	75
	SEC						
IV	KU4SECPHY101	Fundamentals of Data Analytics	2	1	3	4	75
V	KU5SECPHY102	Essential Physics for Forensic Science	3	0	3	3	75
VI	KU6SECPHY103	Maintenance of Electro-Optical Devices	3	0	3	3	75

DISCIPLINE SPECIFIC COURSES

SEMESTER	COURSE CODE	COURSE NAME	CREDITS			HOURS/WEEK	MARKS
			Lecture + Tutorial	Practical	TOTAL		
I	KU1DSCPHY101	Fundamentals Of Physics	3	1	4	5	100
	KU1DSCPHY111	Properties of Matter	3	1	4	5	100
	KU1DSCPHY112	Basic Mechanics	3	1	4	5	100
	KU1DSCPHY113	Introduction to Astrophysics	3	1	4	5	100
	KU1DSCPHY114	Electricity and Magnetism	3	1	4	5	100
	KU1DSCPHY115	Semiconductor Physics and Electronics	3	1	4	5	100
	KU1DSCPHY116	Introduction to Computational Physics	3	1	4	5	100
	KU1DSCPHY117	Molecular & Radiation Biophysics	3	1	4	5	100
II	KU2DSCPHY102	Physics of Solids and Fluids	3	1	4	5	100
	KU2DSCPHY121	Physics of Atoms, Molecules and Nuclei	3	1	4	5	100
	KU2DSCPHY122	Mathematics for Physical Systems	3	1	4	5	100
	KU2DSCPHY123	Fundamentals of Optics	3	1	4	5	100
	KU2DSCPHY124	Heat and Thermodynamics	3	1	4	5	100
	KU2DSCPHY125	Digital Electronics	3	1	4	5	100
	KU2DSCPHY126	Introduction to AI Tools	3	1	4	5	100
	KU2DSCPHY127	Instrumentation Techniques in Biophysics	3	1	4	5	100
III	KU3DSCPHY201	Basic Mathematical Physics	4	0	4	4	100

	KU3DSCPHY202	Mechanics	3	1	4	5	100
	KU3DSCPHY211	Elementary Solid State Physics and Spectroscopy	3	1	4	5	100
	KU3DSCPHY212	Linear Vector Space, Matrices, and Formulation of Quantum Mechanics	3	1	4	5	100
	KU3DSCPHY213	Biophysics	3	1	4	5	100
	KU3DSCPHY214	Oscillations and Waves	3	1	4	5	100
	KU3DSCPHY215	Photonics and Communication	3	1	4	5	100
	KU3DSCPHY216	Mathematical and Computational Modelling in Physics	3	1	4	5	100
	KU3DSCPHY217	Nanobiophysics & Biosensing	3	1	4	5	100
IV	KU4DSCPHY203	Electromagnetics and Circuit Theory	3	1	4	5	100
	KU4DSCPHY204	Electronics I	3	1	4	5	100
	KU4DSCPHY205	Optics	3	1	4	5	100
V	KU5DSCPHY301	Electronics II	3	1	4	5	100
	KU5DSCPHY302	Thermodynamics And Statistical Mechanics	4	0	4	4	100
	KU5DSCPHY303	Modern Physics	3	1	4	5	100
	ELECTIVE (Any Two)						
	KU5DSEPHY301	Computational Physics	4	0	4	4	100
	KU5DSEPHY302	Materials Science	4	0	4	4	100
	KU5DSEPHY303	Radiation Physics	4	0	4	4	100
	KU5DSEPHY304	Atmospheric Physics	4	0	4	4	100
	KU5DSEPHY305	Applied Optics	4	0	4	4	100
VI	KU6DSCPHY304	Electrodynamics I	3	1	4	5	100
	KU6DSCPHY305	Solid State Physics and Spectroscopy	3	1	4	5	100

	KU6DSCPHY306	Quantum Mechanics I	4	0	4	4	100
	ELECTIVE (Any Two)						
	KU6DSEPHY306	Biophotonics	4	0	4	4	100
	KU6DSEPHY307	Nanoscience	4	0	4	4	100
	KU6DSEPHY308	Medical Imaging & Diagnostic Techniques	4	0	4	4	100
	KU6DSEPHY309	Astrophysics	4	0	4	4	100
	KU6DSEPHY310	Plasma and Space Physics	4	0	4	4	100
	KU6INTPHY307	Internship			2		50
VII	KU7DSCPHY401	Mathematical Physics	4	0	4	4	100
	KU7DSCPHY402	Classical Mechanics	3	1	4	5	100
	KU7DSCPHY403	Quantum Mechanics II	4	0	4	4	100
	KU7DSCPHY404	Electrodynamics-II	3	1	4	5	100
	KU7DSCPHY405	Statistical Mechanics	4	0	4	4	100
VIII	KU8DSCPHY 405	Advanced Electronics	4	0	4	4	100
	KU8DSCPHY406	Condensed Matter Physics	4	0	4	4	100
	KU8DSCPHY407	Nuclear and Particle Physics	4	0	4	4	100
	ELECTIVE						
	KU8DSEPHY401	Research Methodology in Physics	4	0	4	4	100
	KU8DSEPHY402	Nonlinear Optics	4	0	4	4	100
	KU8DSEPHY403	Numerical Techniques and Probability Theory	4	0	4	4	100
	KU8DSEPHY404	Experimental Techniques	4	0	4	4	100
	KU8DSEPHY405	MOOC/Online Course			4		
	KU8DSEPHY406	MOOC/Online Course			4		

	KU8DSEPHY407	MOOC/Online Course			4		
	KU8RPHPHY401	Research Project(Honours with research)			12		300
	KU8CIPPHY402	Research Project(Optional) for Honours			8		200
	KU8CIPPHY403	Research Project(Optional) for Honours			12		300

ASSESSMENT AND EVALUATION

- The assessment shall be a combination of Continuous Comprehensive Assessment (CCA) and an End Semester Evaluation (ESE)
- As per the regulation of Kannur University, one credit corresponds to 25 marks. Hence a 3-credit course must be evaluated for 75 marks and 4 credit courses for 100 marks. The ratio of continuous comprehensive assessment (CCA) to End semester examination (ESE) for theory/lecture courses is 30:70 and for the practical courses, it is 40:60.
- The 4-credit courses (Major and Minor courses) and 3 credit (Foundational Courses) are of two types:
  - (i) courses with only theory
  - (ii) courses with 3-credit theory and 1-credit practical.
- In 4-credit courses with only theory component, out of the total 5 modules of the syllabus, one teacher specific module with 20% content is designed by the faculty member teaching that course, and it is internally evaluated .
- In 4-credit courses with 3-credit theory and 1-credit practical components, out of the total 5 modules of the syllabus, 4 modules are for theory and the fifth module is for practical.
- The 3 credit courses (Foundational Courses) are of two types:
  - (i) courses with only theory
  - (ii) courses with 2-credit theory and 1-credit practical.

- In 3-credit courses with only theory component, out of the total 5 modules of the syllabus, one teacher specific module with 20% content is designed by the faculty member teaching that course, and it is internally evaluated .

- In 3-credit courses with 2-credit theory and 1-credit practical components, out of the total 5 modules of the syllabus, 4 modules are for theory and the fifth module is for practical.
- Continuous Evaluation includes assignments, seminars, periodic written examinations, or other measures as proposed in the syllabus and approved by the university.

Practical exams

- The end-semester practical examination and viva-voce, and the evaluation of practical records shall be conducted by the course in-charge and an internal examiner appointed by the Department Council. Duration of ESE may be 2 to 2.5 Hrs.

- There shall be a Continuous Evaluation of practical courses conducted by the Course- In-Charge.
- The process of continuous evaluation of practical courses shall be completed before 10 days from the commencement of the end-semester examination.
- Those who passed in continuous evaluation alone will be permitted to appear for the end-semester examination and viva-voce.

Mark Distribution for Discipline Specific Courses and Foundation Courses

Course Credit	**Credit**		**Mark**		**L**		**P**		
	L	**P**	**L**	**P**	**CCA (30%)**	**ESE (70%)**	**CCA (40%)**	**ESE (60%)**	**Total marks**
4	4	0	100	0	30	70	0	0	100
	3	1	75	25	25	50	10	15	100
	L	**P**	**L**	**P**	**CCA (30%)**	**ESE (70%)**	**CCA (60%)**	**ESE (40%)**	**Total marks**
3	3	0	75	0	25	50	0	0	75
	2	1	50	25	15	35	15	10	75

L – Lecture/Theory , P – Practical/Practicum components, CCA – Continuous Comprehensive Assessment, ESE – End Semester Evaluation

The detailed distribution table with the components

- **4 Credit Course (Theory only)**

Evaluation Type		Marks
ESE		**70**
CCA		**30**
a)	*Test Paper	10
b)	**Assignment/ Book- Article Review	10
c)	Seminar/ Viva -Voce	10
Total		**100**

- **4 Credit Course (3 credit theory + 1 credit practical)**

Evaluation Type			Marks	Evaluation Type			Marks	Total
Lecture			**75**	**Practical**			**25**	**100**
a)	**ESE**		**50**	a)	**ESE**		**15**	
b)	**CCA**		**25**	b)	**CCA**		**10**	
	i	*Test Paper	10		i	Punctuality	3	
	ii	**Assignment/ Book-Article review	10		ii	Skill	4	
	iii	Seminar/ Viva-Voce	5		iii	Record	3	

- **3 Credit Course (Theory only)**

<table>
<tr><th colspan="2">Evaluation Type</th><th>Marks</th></tr>
<tr><td colspan="2">ESE</td><td>50</td></tr>
<tr><td colspan="2">CCA</td><td>25</td></tr>
<tr><td>a)</td><td>*Test Paper</td><td>10</td></tr>
<tr><td>b)</td><td>**Assignment/ Book- Article Review</td><td>5</td></tr>
<tr><td>c)</td><td>Seminar/ Viva -Voce</td><td>10</td></tr>
<tr><td colspan="2">Total</td><td>75</td></tr>
</table>

- **3 Credit Course (2 credit theory + 1 credit practical)**

<table>
<tr><th colspan="3">Evaluation Type</th><th>Marks</th><th colspan="3">Evaluation Type</th><th>Marks</th><th>Total</th></tr>
<tr><td colspan="3">Lecture</td><td>50</td><td colspan="3">Practical</td><td>25</td><td rowspan="6">100</td></tr>
<tr><td>a)</td><td colspan="2">ESE</td><td>35</td><td>a)</td><td colspan="2">ESE</td><td>10</td></tr>
<tr><td>b)</td><td colspan="2">CCA</td><td>15</td><td>b)</td><td colspan="2">CCA</td><td>15</td></tr>
<tr><td></td><td>i</td><td>*Test Paper</td><td>8</td><td></td><td>i</td><td>Punctuality</td><td>5</td></tr>
<tr><td></td><td>ii</td><td>**Book-Article review/ Assignment</td><td>2</td><td></td><td>ii</td><td>Skill</td><td>5</td></tr>
<tr><td></td><td>iii</td><td>Seminar/ Viva-Voce</td><td>5</td><td></td><td>iii</td><td>Record</td><td>5</td></tr>
</table>

* Best out of two test papers

** Or any other evaluation technique like quiz, open book exam, group activity

INTERNSHIP

- All students should undergo Internship of 2-credits during the first six semesters in a firm, industry or organization, or training in labs with faculty and researchers of their own institution or other Higher Educational Institutions (HEIs) or research institutions.
- Internship can be for enhancing the employability of the student or for developing the research aptitude.
- Internship can involve hands-on training on a particular skill/ equipment/ software. It can be a short project on a specific problem or area. Attending seminars or workshops related to an area of learning or skill can be a component of Internship.
- A faculty member/ scientist/ instructor of the respective institution, where the student does the Internship, should be the supervisor of the Internship.

Guidelines for Internship

- Internship can be in Physics or allied disciplines.
- There should be minimum 60 hrs. of engagement from the student in the Internship.
- Summer vacations and other holidays can be used for completing the Internship.
- In BSc. Physics Honours programme, institute/ industry visit or study tour can be part of Internship. Visit to national research institute, research laboratory and place of scientific importance should be part of the study tour. A brief report of the study tour has to be submitted with photos.
- The students should make regular and detailed entries in to a personal log book through the period of Internship. The log book will be a record of the progress of the Internship and the time spent on the work, and it will be useful in writing the final report. It may contain experimental conditions and results, ideas, mathematical expressions, rough work and calculation, computer file names etc. All entries should be dated. The Internship supervisor should periodically examine and countersign the log book.
- The log book and the report must be submitted at the end of the Internship.
- The institution at which the Internship will be carried out should be prior-approved by the Department Council of the College where the student has enrolled for the UG Honours programme.

Evaluation of Internship

- The evaluation of Internship shall be done internally through continuous assessment mode by a committee internally constituted by the Department Council of the college where the student has enrolled for the UG Honours programme.
- The credits and marks for the Internship will be awarded only at the end of semester 6.

The scheme of CCA and ESE is given below:

Components of Evaluation of Internship	**Weightage**	**Marks for Internship 2 Credit/50 Marks**
Continuous Comprehensive Assessment (CCA)	30%	15
End Semester Evaluation	70%	35

The detailed distribution table with the components

Evaluation Type		**Marks**
ESE		**35**
a)	Acquisition of skill	20
b)	Report	15
CCA		**15**
a)	Punctuality	5
c)	Logbook	10
Total		**75**

PROJECT IN HONOURS PROGRAMME

- In Honours programme, the student has the option to do a Project of 12-credits in Major instead of three major Courses or Project of 8-credits in Major and one major course in semester 8.
- The Project can be done in the same institution/ any other higher educational institution (HEI) / research centre/ training centre.
- The Project in Honours programme can be a short research work or an extended internship or a skill-based training programme.
- A faculty member of the respective institution, where the student does the Project, should be the supervisor of the Project.

PROJECT IN HONOURS WITH RESEARCH PROGRAMME

- Students who secure 75% marks and above (equivalently, CGPA 7.5 and above) cumulatively in the first six semesters are eligible to get selected to Honours with Research stream in the fourth year.
- In Honours with Research programme, the student has to do a mandatory Research Project of 12-credits instead of three Core Courses in Major in semester 8.
- The number of seats for the Honors with research shall be determined as per the availability of eligible faculty.
- The selection criteria for Honors with research stream shall be in accordance with the guidelines of UGC or as approved by Kannur University.
- Students who have chosen the honours with research stream shall be mentored by a faculty with a PhD.
- The mentor shall prescribe suitable advanced-level courses for a minimum of 20 credits to be taken within the institutions along with the papers on research methodology, research ethics, and research topic-specific courses for a minimum of 12 credits which may be obtained either within the institution or from other recognized institutions, including online and blended modes.
- These students who have opted for the honours with research should complete a research project under the guidance of the mentor and should submit a research report for

evaluation. They need to successfully defend the research project to obtain 12 credits under a faculty member of the University/College within the University.

- The research outcomes of their project work may be published in peer-reviewed journals or presented at conferences or seminars or patented.

Guidelines for the Project in Honours Programme and Honours with Research Programme

- Project can be in Physics or allied disciplines.
- Project should be done individually.
- Project work can be of experimental/ theoretical/ computational in nature.
- There should be minimum 360 hrs. of engagement from the student in the Project work in Honours programme as well as in Honours with Research programme.
- There should be minimum 13 hrs./week of engagement (the hours corresponding to the three core courses in Major in semester 8) from the teacher in the guidance of the Poject(s) in Honours programme and Honours with Research programme.
- The various steps in project works are the following:
  - ✓ Review
  - ✓ Investigation on a problem in systematic way.
  - ✓ Systematic recording.
  - ✓ Reporting the results with interpretation in a standard documented form.
  - ✓ Presentation of the results before the examiners.
- The report must be submitted at the end of the Project. A copy of the report should be kept for reference at the department. A soft copy of the report too should be submitted, to be sent to the external examiner in advance.
- The project report shall have an undertaking from the student and a certificate from the research supervisor for originality of the work, stating that there is no plagiarism, and that the work has not been submitted for the award of any other degree/ diploma in the same institution or any other institution.

Evaluation of Project

- The evaluation of Project will be conducted at the end of the eighth semester by both internal and external modes.
- The internal evaluation of the Project work shall be done through continuous assessment mode by a committee internally constituted by the Department Council of the college where the student has enrolled for the UG Honours programme. 30% of the weightage shall be given through this mode.
- The remaining 70% shall be awarded by the external examiner appointed by the University.

The scheme of evaluation of the Project is given below:

Project type	**Maximum Marks**	**CCA (30%)**	**ESE (70%)**
Research Project of 12 Credits (UG Honours with research, mandatory)	300	90	210
Research Project of 12 Credits (UG Honours, optional)	300	90	210
Research Project of 8 Credits (UG Honours, optional)	200	60	140

The detailed distribution table with the components

CCA			
Sl. No	Components of Evaluation of Project	Marks for the Project (Honours/Honours with Research) 12 credits	Marks for the Project (Honours/Honours with Research) 8 credits
1	Skill in doing project work	30	20
2	Internal Presentation and Viva-Voce	20	15
3	Punctuality and attendance*	20	15

4	Organization of Project Report	20	10
Total Marks		**90**	**60**

*Attendance certificate should be produced by the students who have done their projects in any higher educational institution (HEI)/ research centre/ training centre.

ESE			
Sl. No	Components of Evaluation of Project	Marks for the Project (Honours/ Honours with Research) 12 credits	Marks for the Project (Honours/ Honours with Research) 8 Credits
1	Content and relevance of the Project, Methodology, Quality of analysis, and Innovations of Research	50	40
2	Presentation of the Project	50	30
3	Project Report	40	20
4	Viva-Voce	70	50
Total Marks		**210**	**140**

EXTERNAL EVALUATION

- Examinations will be conducted at the end of each semester. The students can write the external examinations in physics in both English and Malayalam languages.
- Individual questions are evaluated in marks and the total marks are converted into grades by the University based on 10-point grading system.

Letter Grade	Grade Point (P)
O (Outstanding)	10
A+ (Excellent)	9
A (Very Good)	8
B+ (Good)	7
B (Above Average)	6
C (Average)	5
P (Pass)	4
F (Fail)	0
Ab (Absent)	0

- A minimum of grade point 4 (Grade P) is needed for the successful completion of a Course.
- A student who has failed in a Course can reappear for the End Semester Examination of the same Course along with the next batch without taking re-admission or choose another Course in the subsequent Semesters of the same programme to acquire the minimum credits needed for the completion of the Programme.
- There shall not be provision for improvement of CE and ESE.
- A student who has successfully completed the CE requirements in a subsequent semester can also appear for the ESE subject to the maximum duration permitted.

Computation of SGPA and CGPA

The following method is recommended to compute the Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA):

- The SGPA is the ratio of the sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses undergone by a student, i.e. **SGPA** (S_i) = $\Sigma(C_i \times G_i) / \Sigma C_i$ Where C_i is the number of credits of the course and G_i is the grade point scored by the student in the course.

Example:

Semester	Course	Credit	Letter Grade	Grade point	Credit Point (Credit x Grade)
I	Course 1	3	A	8	3 X 8 = 24
I	Course 2	4	B+	7	4 X 7 = 28
I	Course 3	3	B	6	3 X 6 = 18
I	Course 4	3	O	10	3 X 10 = 30
I	Course 5	3	C	5	3 X 5 = 15
I	Course 6	4	B	6	4 X 6 = 24
		20			139
SGPA					139/20=**6.95**

- The Cumulative Grade Point Average (CGPA) is also calculated in the same manner taking into account all the courses undergone by a student over all the semesters of a programme, i.e. CGPA = Σ(Ci x Si) / Σ Ci Where Si is the SGPA of the semester and Ci is the total number of credits in that semester.
- The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts. Transcript (Format): Based on the above recommendations on Letter grades, grade points and SGPA and CCPA, the HEIs may issue the transcript for each semester and a consolidated transcript indicating the performance in all semesters.

Example:

Semester I	Semester II	Semester III	Semester IV	Semester V	Semester VI
Credit: 21 SGPA: 6.9	Credit: 21 SGPA: 7.8	Credit: 22 SGPA: 5.6	Credit: 24 SGPA: 6.0	Credit: 23 SGPA: 6.3	Credit: 22 SGPA: 8.0
CGPA=(21 x 6.9 + 21 x 7.8 + 22 x 5.6 + 24 x 6.0 + 23 x 6.3 + 22 x 8.0) / 133 = 6.74					

- The SGPA is the ratio of the sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses undergone by a student, i.e. **SGPA** (Si) = Σ(Ci x Gi) / ΣCi Where Ci is the number of credits of the course and Gi is the grade point scored by the student in the course.

CGPA	**Overall letter Grade**
9.5 and above	**O**
8.5 and above but less than 9.5	A+
7.5 and above but less than 8.5	A
6.5 and above but less than 7.5	B+
5.5 and above but less than 6.5	B
4.5 and above but less than 5.5	C
4.0 and above but less than 4.5	D
Less than 4.0	F

Appearance for Continuous Evaluation (CE) and End Semester Examination (ESE) are compulsory, and no Grade shall be awarded to a candidate if the candidate is absent for CE or ESE or both.

SYLLABUS

GENERAL FOUNDATION COURSES

KU1MDCPHY101 : Physics Around Us

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
I	MDC	100	KU1MDCPHY101	3	45

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture+ Tutorial	Practical	CE	ESE	Total	
3	0	25	50	75	1.5

Course Description:

Physics around us is a descriptive course that deals with the applications of physics to commonly experienced phenomena and machines. This course would enable the students to identify, analyse, and solve problems encountered in everyday situations using principles of physics,

Course Prerequisite: NIL

Course Outcomes

CO No.	Expected Outcome	Learning Domains
1	Understand and apply the principles of physics to several day-to-day phenomena.	*U,A*
2	Understand heat transfer and the working of common kitchen appliances	*U*
3	Apply the principles of physics to the sport of soccer.	*A*
4	Analyse various interesting natural phenomena based on principles of physics	*An*

***Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)**

Mapping of Course Outcomes to PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	1	2	3	2	1
CO2	3	3	1	2	3	1	0
CO3	2	2	0	2	3	1	0
CO4	3	3	2	3	3	2	0

Correlation level 0-None, 1-Slight, 2-Medium, 3-High

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**Physics in daily life**		**10**
	1	You go to the doctor	5
	2	You go to the airport	3
	3	You take a flight	2
	Chapters 3 - 5 of Book 1		
2	**Physics in Kitchen**		**9**
	1	Advantages and disadvantages of using LPG and electricity as energy sources in the kitchen – physics of induction cooktop -physics of microwave oven	3
	2	Smoke detectors ,Purpose and use of different metals as kitchen utensils	2
	3	Working of refrigerator	2

	4	Energy wastage in the kitchen and solutions	2
	Chapters 5, 6 of Book 2		
3	**Physics in sports-The science of Soccer**		**8**
	1	The kick , Forces on the foot – power – the curled kick	2
	2	The throw-in, goalkeeper's throw, heading, punching, catching, receiving, trapping the football	2
	3	Airflow around the ball – the boundary layer	2
	4	The Bernoulli effect – speed and range, effect of a wind	2
	Chapters 2, 3, 4 of Book 3		
4	**The Wonders of Physics**		**9**
	1	Outside and inside the rainbow-secrets of the rainbow, why sailors wear sunglasses, beyond the rainbow	3
	2	The harmonies of strings and winds, sound waves in space? -the wonders of resonance, the music of the winds, dangerous resonance	3
	3	The wonders of electricity-static electricity, invisible induction, electric fields and sparks, divine sparks	3
		Chapters 5, 6, and 7 of Book 4	
5	**Teacher Specific Module**		**9**
	Directions:		
	Activities or simulations designed by the teacher to demonstrate the applications of principles of physics in day-to-day phenomena		

Essential Readings:

1. The Physics of everyday things , James Kakalios, Crown Publishers , Newyork, 2017
2. Physics in the Kitchen, George Vekinis, Springer Nature Switzerland, 2023.
3. The Science of Soccer, John Wesson, Institute of Physics Publishing, 2002
4. For the love of Physics, Walter Lewin, Free Press, 2012

Suggested Readings:

1. https://www.physics.hku.hk/~phys1055/lectures/chap05.html

Assessment Rubrics:

Evaluation Type		Marks
ESE		**50**
CCA		**25**
a)	*Test Paper	10
c)	**Assignment/ Book- Article Review	5
d)	Seminar/ Viva -Voce	10
Total		**75**

*Best out of two test papers

** or any other activities like quiz, open book exam, group activity

KU2MDCPHY102 : Wonders of The Cosmos

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
II	MDC	100	KU2MDCPHY102	3	45

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture+ Tutorial	Practical	CE	ESE	Total	
3	0	25	50	75	1.5

Course description:

This course offers an introduction to astronomy and provides students a foundational understanding of observational astronomy, celestial objects and basic techniques for amateur stargazing. Students will gain practical skills and theoretical knowledge to explore the wonders of the cosmos through a combination of lectures, demonstrations, and observations

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the historical development of astronomy from ancient models to modern theories	*U*
2	Analyse the contributions of Ptolemy, Copernicus, Galileo, and Kepler in astronomy	*An*
3	Understand the fundamental concepts of celestial sphere, celestial coordinates, and motion of celestial bodies	*U*

4	Apply scientific reasoning to interpret astronomical observations and phenomena	*A*
5	Interpret the causes and effects of celestial phenomena such as eclipses, apply observational techniques to locate and identify celestial objects in night sky	*U,A*

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs/POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	2	1	2	2	3	2
CO2	3	2	1	3	3	3	2
CO3	3	3	2	3	3	2	1
CO4	3	3	2	3	3	3	2
CO5	3	3	2	3	3	3	1

Correlation level 0-None, 1-Slight, 2-Medium, 3-High

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**Introduction to Astronomy**		**10**

	1	The Nature of Astronomy, The Nature of Science, The Laws of Nature, Numbers in Astronomy, A Tour of the Universe, The Universe on the Large Scale, The Universe of the Very Small, A Conclusion and a Beginning	3
	2	Ancient Astronomy- Astronomy around the World, Early Greek and Roman Cosmology, Ptolemy's Model of the Solar System, Astrology and Astronomy, the beginnings of Astrology, the Horoscope, Astrology Today	3
	3	The Birth of Modern Astronomy-Copernicus, The Heliocentric Model, Galileo and the Beginning of Modern Science, Galileo's Astronomical Observations, Kepler's Laws of Planetary Motion, Orbits in the Solar System	3
		Sections 1.1-1.4,1.6-1.9, 2.1-2.4, 3.1, 3.4, 6.1 Book 1	
2	**Night sky & Moon**		**6**
	1	Darkness and Light, Finding Your Way around the Sky, Cosmic Protractor, Special Effects, Night Vision, The Milky Way	2
	2	Moon: Phases of Moon, Characteristics, Moonrise, Moonset, Moon Illusion	2
	3	Sightseeing on the moon, Lunar topography, Formation, Lunar Eclipse	2
	Chapter 1 & 2 of Book 2		
3	**Sun and Planets**		**10**
	1	Sun, how seasons happen, Sun paths, Telling time by the Sun, A visit to the sun, Power house, Storms on Sun, How the Sun formed, Our sun is born	2
	2	Solar Eclipse, How Are Eclipse of the Sun and Moon the Same-and Different? Why Can't We Look at the Sun? What to take eclipse-watching	2
	3	Planets: Earth's siblings in the sky, Star or Planet? Sky Wanderer, Roaming around Solar system	2
	4	Terrestrial & Jovian Planets, Small solar system Bodies, Meet the eight planets	2

	5	How the Solar System Formed, Comets, Other suns and their Solar Systems	2
	Chapter 3 and 4 of Book 2		
4	**Stars & Constellations**		**10**
	1	Stars and Constellations: How stars move during the night, North star	2
	2	North & South Using the Stars, The Zodiac, and the Ecliptic, Rasis & Nakshatras	2
	3	Seasonal Sky gazing Northern Hemisphere - November, December & January Stars. (Constellations Orion, Canis Major, Lepus, Taurus, Gemini, Auriga)	3
	4	How Stars Are Born, Live, and Die, Meteor Shower. Deep Sky Objects.	3
	Chapter 5 of Book 2 and Chapter 3 & 10 of Book 3		
5	**Teacher Specific Module**		**9**
	Directions		
	Demonstrations using Stellarium or any other sky guide apps – constellations, eclipses, planetary alignment etc.		

Essential Readings:

1. Astronomy 2e by Andrew Fraknoi, David Morrison, and Sidney C. Wolff, OpenStax CNX , 2022. Web version 2024. https://open.umn.edu/opentextbooks/textbooks/390
2. Sky Gazing- A Guide to the Moon, Sun, Planets, Stars, Eclipses, and Constellations by MegThacher, Storey Publishing, 2020.
3. The Joy of Star watching 3rd Edn by Biman Basu, National Book Trust, India, 2022.

Assessment Rubrics:

Evaluation Type		Marks
ESE		**50**
CCA		**25**
a)	*Test Paper	10
c)	**Assignment/ Book- Article Review	5
d)	Seminar/ Viva -Voce	10
Total		**75**

*Best out of two test papers

** or any other activities like quiz, open book exam, group activity

KU3VACPHY101: Radiation Hazards and Protection

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
III	VAC	100	KU3VACPHY101	3	45

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture+ Tutorial	Practical	CE	ESE	Total	
3	0	25	50	75	1.5

Course description:

This comprehensive course, Radiation Hazard, and Protection, provides an in-depth exploration of the principles, units, and effects of radioactivity and radiation. The course is structured to cover the fundamental concepts of radioactivity, the interactions of radiation with matter, and the biological effects of radiation exposure. Emphasis is placed on understanding radiation units and quantities, evaluating radiation exposure from natural and artificial sources, and implementing radiological protection principles based on the recommendations of the International Commission on Radiological Protection (ICRP). Through this course, students will gain the necessary knowledge to assess and manage radiation risks in various settings, including occupational, medical, and public environments.

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the fundamental concept of radioactivity	*U*
2	Understand and evaluate biological effects of radiation	*U, E*

3	Mastering radiation units and quantities, Identify and manage natural radiation sources	*An*
4	Implement the principles of radiological protection, Practise radiological protection in various exposure situations	*A, An*

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	2	3	3	3	2	1
CO 2	3	2	3	3	3	2	3
CO 3	3	2	3	3	3	2	2
CO 4	3	2	2	3	3	3	2
CO 5	3	2	2	3	3	2	3

Correlation level 0-None, 1-Slight, 2-Medium, 3-High

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**Radioactivity And Radiation**		**7**
	1	Radioactivity, specific activity, half-life, X-rays and gamma rays, alpha particles, specific ionization, range of alpha particles, beta particles, range of beta particles,	3
	2	Examples of naturally occurring beta emitters, range of protons, bremsstrahlung radiation, positron emission, emission of gamma rays	2

	3	interaction of radiation with matter	2
		Book 1, Chapter 2	
2	**Radiation Units and Quantities**		**8**
	1	Activity, exposure unit, Roentgen, kerma, absorbed dose, protection quantities, mean radiation absorbed dose, linear energy transfer (LET)	2
	2	Radiation weighting factor, equivalent dose, significant new findings, auger electrons, tissue weighting factor, effective dose	2
	3	significant new findings in tissue weighting factor, committed effective dose,	2
	4	occupational exposure situation, application of effective dose, collective effective dose	2
	5	**Book 1, Chapter 3**	
3	**Effects of Radiation and Exposure from Natural Sources**		**10**
	1	Effects of Radiation at the cellular level, terminology for bands of absorbed dose,	2
	2	Deterministic effects, acute radiation syndrome, stochastic effects, double strand breaks	2
	3	Applicability of LNT model for projecting cancer risk, dose and dose rate effectiveness factor, Computation of radiation detriment, the LSS for the risk estimates, non-cancer diseases after radiation exposure, exposure of the skin,	3
	4	Calculation of dose to the skin, exposure to the lens of the eye, natural radioactive sources, exposure to cosmic rays, exposure to natural radionuclides of terrestrial origin, background radiation dose levels.	3
		Book 1, Chapter 4 & 6	
4	**Radiological Protection**		**11**
	1	Evolution of ICRP recommendations, ICRP publications	3
	2	Identification of the exposed individual, occupational worker, members of the public, representative person, pregnant and breastfeeding workers, embryo, and foetus tissue,	2

	3	Patients undergoing radiological investigation/treatment, aviation crew, planned exposure situations, emergency exposure situation, existing exposure situation	3
	4	The principles of radiological protection, justification, unjustifiable exposure, optimization, evolution of dose limits, basis for dose limits, dose constraint, reference level, dose limits.	3
		Book 1, Chapter 7	
5	**Teacher Specific Module**		**9**
	Directions:		
	Activities designed by the course faculty related to the topic.		

Essential Readings:

1. Radiological Protections and Safety - A Practitioner's Guide by Pushparaja, Notion Press, 2019.

Suggested Readings:

1. Radiation Detection and Measurement, G F Knoll, John Wiley & Sons, New York, 2000.
2. Basic Radiological Physics, K Thayalan, Jaypee Brothers Medical Publishers, New Delhi, 2003
3. Fundamental Physics of Radiology, W J Meredith and J B Massey, 3rd Edn., 1983.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**50**
Continuous Evaluation		**25**
a)	*Test Paper	10
c)	**Assignment/ Book- Article Review	5
d)	Seminar/ Viva -Voce	10
Total		**75**

*Best out of two test papers

** or any other activities like quiz, open book exam, group activity

KU4VACPHY102 : Green Energy for Sustainability

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
IV	VAC	100	KU4VACPHY102	3	45

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture+ Tutorial	Practical	CE	ESE	Total	
3	0	25	50	75	1.5

Course description:

This course is great for beginners who want to learn about clean energy and help the planet.

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Gain a comprehensive understanding of energy scarcity causes, explore energy source classifications, examine solutions to energy crises, focus on global and Indian perspectives on renewable energy, and study solar energy, including challenges, applications, and solar cell systems.	*R, U*
2	Acquire foundational knowledge of hydrogen energy, including its benefits, storage methods, and applications, while critically evaluating both	*U, An*

	advantages and disadvantages along with associated problems.	
3	Comprehend principles of wind energy, assess its status in India, explore geothermal energy classifications and utilisation, and analyse tidal energy resources, availability, power generation, and associated advantages and disadvantages.	*U*
4	Understand the impact of solid waste and agricultural refuse on health, explore biomass energy, study biomass production, energy plantations, and biogas energy, including composition, production, construction, working, and the benefits of biogas plants.	*U*

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	3	3	2	3	2	2
CO 2	3	3	2	3	2	3	3
CO 3	3	3	3	3	2	3	2
CO 4	3	3	3	3	3	2	2

Correlation level 0-None, 1-Slight, 2-Medium, 3-High

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**Solar Energy**		**9**
	1	Causes of Energy Scarcity - Energy sources and classification - Solution to energy crisis or scarcity- Renewable energy	2
	2	Worldwide Renewable Energy Availability - Renewable Energy in India- Energy from the Sun - Sun Earth geometric relationship	2
	3	Solar energy reaching the Earth's surface - Problems Associated with Harnessing Full Solar Energy	2
	4	Solar thermal energy applications- Solar thermal energy storage - Solar cells - Need for solar cells - Components of a Solar Cell System - Solar cell materials -Applications of solar cell systems	3
		Sections: 1.5,1.6, 1.9, 1.12, 1.12.1, 1.12.2, 2.1, 2.4, 2.4.1, 2.5, 2.6, 4.1, 4.1.1, 4.2, 4.2.1, 4.2.2, 4.8	
2	**Hydrogen Energy**		**9**
	1	Hydrogen Energy - Introduction- Benefits of hydrogen energy	2
	2	Hydrogen energy storage - Use of hydrogen energy	2
	3	Applications of hydrogen energy- Advantages of hydrogen energy- Disadvantages of hydrogen energy	3
	4	Problems associated with hydrogen energy	2
		Sections: 5.1, 5.3 to 5.8	
3	**Wind and Tidal Energy**		**9**
	1	Wind Energy - Windmills - Wind Turbines - Wind energy in India	2
	2	Geothermal energy- Geothermal systems- Classifications - Geothermal resource utilisation	3
	3	Prospects of Geothermal Fields in India - Associated problems- Environmental effects	2

	4	Tidal energy - General - Tidal energy resources - Tidal energy availability - Tidal power generation in India - Advantages and disadvantage of tidal power	2
		Sections: 6.1, 6.2, 6.4.2, 7.1, 7.2,7.3, 7.4.1, 7.6, 7.7, 11.1 -11.4, 11.9	
4	**Biomass energy**		**9**
	1	Solid waste and agricultural refuse - Waste is health - Biomass energy	3
	2	Biomass production- Energy plantation - Biogas energy	2
	3	Introduction - Biogas and its composition - Biogas production	2
	4	Construction parts of Biogas plants - Working of Biogas plant - Benefits of Biogas	2
		Sections: 8.1, 9.1, 9.2, 10.1, 10.2, 10.4, 10.4.1, 10.4.2, 10.5	
5	**Teacher Specific Module**		**9**
	Directions: Can be designed by the course faculty		

Essential Readings:

1. Non-Conventional Energy Resources, Shobh Nath Singh, Published by Pearson India Education Services Pvt. Ltd, 2015.

Suggested Readings:

1. Non-conventional energy sources-G. D. Rai, Khanna Publishers

Assessment Rubrics:

Evaluation Type		**Marks**
ESE		**50**
CCA		**25**
a)	*Test Paper	10
c)	**Assignment/ Book-Article Review	5
d)	Seminar/ Viva -Voce	10
Total		**75**

*Best out of two test papers

** or any other activities like quiz, open book exam, group activity.

KU4VACPHY103 : Scientific Ethics

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
IV	VAC	100	KU4VACPHY103	3	45

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture+ Tutorial	Practical	CE	ESE	Total	
3	0	25	50	75	1.5

Course description:

The ethics of the design, execution, and reporting of research are referred to as research ethics. Ethical norms are to be followed in publication also. This course aims at equipping the students with a knowledge of various research misconducts, its coasts, and the need and methods to avoid scientific misconduct. The student will have an insight about the research ethical committees and its function. Various ethical issues related to the publication also forms a part of this course.

Course Prerequisite: NIL

Course Outcomes

CO No.	Expected Outcome	Learning Domains
1	Appreciate the importance of ethical practices in research	*R*
2	Understand various unethical practices in research and publication	*U*
3	Understand the importance of intellectual honesty and integrity in research	*U*

4	Understand the role and responsibilities of research ethics committees	*U*

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs/POs

	PSO 1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	1	1	3	1	0	1	3
CO2	1	3	3	0	1	1	3
CO3	1	3	3	1	2	0	3
CO4	1	3	3	1	1	0	3

Correlation level 0-None, 1-Slight, 2-Medium, 3-High

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**Research Ethics**		**8**
	1	Importance of research ethics, values and principles of ethics - Scientific Integrity and Research Ethics	2
	2	Intellectual property rights, autonomy, dignity, beneficence/non-maleficence, Vulnerability and Justice	2

	3	Conflict of interest and undesirable authorships	2
	4	Costs of scientific misconduct.	2
		Book 1: **Section 9.1-9.3, 9.4, 9.5.6, 9.5.7, 9.7, Book 2: chapter 3**	
2	**Intellectual Honesty and Research Integrity**		**9**
	1	Environment and bases of research integrity, promoting research integrity	2
	2	Integrity of individual research, support by research institution	3
	3	Fostering integrity in research and promoting honesty in research	2
	4	Research environment and its impact on research integrity	2
		Book 2: Chapter 4	
3	**Scientific Misconduct**		**10**
	1	Poor Practices v/s. Misconduct, Examples for scientific misconduct, Falsifying and Fabricating of Data, stealing of credit, Omission of data, misinterpretation of previous work, intentional negligence in acknowledging previous work, passing off another researcher's data as one's own	4
	2	Plagiarism, different forms of plagiarism and methods to avoid plagiarism	2
	3	Regulations of plagiarism, tools for plagiarism checking - Research ethics committees and functions	2
	4	Institutional Responses to Scientific Misconduct and Administrative Responses to Scientific Misconduct	2
		Book 1: Sections 9.5.1, 9.5.2, 9.5.3, 9.8, 9.9, Book 2: chapter 5	
4	**Publication Ethics**		**9**
	1	Ethical issues in publication, types of publication misconduct	3
	2	Ethical responsibilities of authors, editors and reviewers	2
	3	Redundant publication and problems caused by redundant publication	2
	4	Misconduct by Editors, Publishers, and Peer-Reviewers.	2
		Book 1: Section 10.5-10.7, Book 2: chapter 7 and 8	
5	**Teacher Specific Module**		**9**

	Directions: Course faculty can design content.	

Essential Readings:

1. Research Methodology for Scientific Research, (Second Edition), K. Prathapan, I K International Publishers, New Delhi, (2023)
2. Research and Publication Ethics, Santhosh Kumar Yadav, Anne Books PVT. Ltd. New Delhi (2022)

Suggested Readings:

1. Ethics in Science, John G D'Angelo, (Second Edition) CRC Press (2019)
2. Responsible Conduct of Research, Adil E. Shamoo and David B. Resnik, Oxford University Press, (2009).
3. Student's Guide to Research Ethics, Paul Oliver, Open University Press Maidenhead · Philadelphia (2003).
4. Research and Publication Ethics, Nimit Chowdhary, Sunayana, and Monika Prakash, Routledge India, (2023).
5. Research Ethics for Scientists, C. Neal Stewart Jr, Wiley Blackwell (2011).
6. Scientific Integrity and Research Ethics, David Koepsell, Springer Nature (2015).

Assessment Rubrics:

Evaluation Type		**Marks**
ESE		**50**
CCA		**25**
a)	*Test Paper	10
c)	**Assignment/ Book- Article Review	5
d)	Seminar/ Viva -Voce	10
Total		**75**

*Best out of two test papers

** or any other activities like quiz, open book exam, group activity

KU4SECPHY101:Fundamentals of Data analytics

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
IV	SEC	100	KU4SECPHY101	3	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture+ Tutorial	Practical	CE	ESE	Total	
2	2	30	45	75	1.5

Course description:

This course provides a comprehensive introduction to statistical concepts and methods. This also introduces data handling modules of Python. Practical applications and problem-solving are emphasized through real-world examples and exercises.

Course Prerequisite: Higher secondary level Mathematics/ statistics

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand and apply knowledge about data.	*U,A*
2	Analyse and use different data analysis tools and software	*An , A*
3	Understand different data sampling methods and use graph plotting.	*U, A*
4	Apply different software tools for data analysis.	*A*

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	3	3	3	1	1	1
CO 2	3	3	2	2	1	0	1
CO 3	3	3	3	3	0	1	0
CO 4	3	3	3	2	2	0	0

Correlation level 0-None, 1-Slight, 2-Medium, 3-High

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**Sampling and data**		**8**
	1	Definition of statistics, probability and key terms	**2**
	2	Data, sampling, and variation in data and sampling	**2**
	3	Frequency, Frequency tables, and levels of measurement	**2**
	4	Stemplot, Line graphs and Bar graph, histogram, Frequency polygon and time series graph.	**2**
	Sections 1.1,1.2,1.3, 2.1, 2.2 of Book 1		
2	**Data file formats**		**8**
	1	Introducing different data file formats: csv, xls, tab, dat formats.	2
	2	Jupyter Notebooks using Anaconda and Google Colab: introduction	2

	3	Familiarisation with Google Colab 1, Familiarization with Anaconda 2	2
	4	Reading data files in Jupyter Notebooks	2
		Book 1	
3	**Using Pandas for Data Analysis**		**8**
	1	Data Analysis Using Pandas: Series and dataframe, creating data	2
	2	frame from an excel spreadsheet - creating data frame from .csv files. Creating data frame from a python dictionary - creating data frame from python list of tuples - viewing data frame using loc() and iloc().	2
	3	Operations on data frames series object - creating series from a data frame - creating data frame from series - creating series from numpy array.	2
	4	Converting series into numpy array - creating series from a dictionary- accessing elements of a series, Joining data frames - how to join when there is no common column - concatenation of tables - where() method - groupby() method, aggregate functions on data frames.	2
		Chapters 12,13 (SQL & Regular expressions not required**) of Book 1**	
4	**Data Visualization using Seaborn**		**6**
	1	Loading datasets in Seaborn, Distribution plot Count plot, box plot, scatter plot, joint plot. Line Plot, displaying scatter plot with regression	3
	3	Creating subplots 1, Heat map - cat plot 2, Violin plot - pair plot. 2	3
		Chapter 15 of Book 1	
5	**Practical Module**		**30**
	Directions:		
	Practical related with data analysis and manipulations		

Essential Readings:

1. Introductory Statistics, Barbara Illowsky, De Anza College, Susan Dean-De Anza College, OpenStax, 2018.
2. Machine Learning in Data Science using Python, Dr. R. Nageswara Rao, Dreamtech press, 2022

Suggested Readings:

1. Statistics 4th Edition -David Freedman, Robert Pisani, Roger Purves, W. W. Norton& Company, 2007.

Assessment Rubrics:

<table>
<tr><th colspan="3">Evaluation Type</th><th>Marks</th><th colspan="3">Evaluation Type</th><th>Marks</th><th>Total</th></tr>
<tr><td colspan="3">Lecture</td><td>50</td><td colspan="3">Practical</td><td>25</td><td rowspan="6">75</td></tr>
<tr><td>a)</td><td colspan="2">ESE</td><td>35</td><td>a)</td><td colspan="2">ESE</td><td>10</td></tr>
<tr><td>b)</td><td colspan="2">CCA</td><td>15</td><td>b)</td><td colspan="2">CCA</td><td>15</td></tr>
<tr><td></td><td>i</td><td>*Test Paper</td><td>8</td><td></td><td>i</td><td>Punctuality</td><td>5</td></tr>
<tr><td></td><td>ii</td><td>**Book-Article review/ Assignment</td><td>2</td><td></td><td>ii</td><td>Skill</td><td>5</td></tr>
<tr><td></td><td>iii</td><td>Seminar/ Viva-Voce</td><td>5</td><td></td><td>iii</td><td>Record</td><td>5</td></tr>
</table>

*Best out of two test papers

** or any other activities like quiz, open book exam, group activity

KU5SECPHY102: Essential Physics for Forensic Science

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
V	DSC	100	KU5SECPHY102	3	45

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture+ tutorial	Practical	CE	ESE	Total	
3	0	25	50	75	1.5

Course description:

Forensic Science is an interdisciplinary field that applies scientific principles and techniques to solve crimes and ensure justice. This course covers the analysis of physical evidence, crime scene investigation, forensic Physics, and forensic ballistics.

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the fundamental principles and significance of forensic science	*U*
2	Understanding the working of the forensic establishments in India and abroad.	*U*

3	Analyse the methods of securing, searching and documenting crime scenes, the art of collecting, packaging, and preserving different types of physical and trace evidence at crime scenes.	*An*
4	Familiarise the tools and techniques for analysis of different types of crime scene evidence. Classify firearms and understand firing mechanisms.	*U, An*

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	2	1	1	1	1	0
CO 2	3	3	1	1	0	1	1
CO 3	3	3	3	1	2	1	1
CO 4	3	3	3	1	1	1	2
CO 5	3	2	1	3	3	2	1

Correlation level 0-None, 1-Slight, 2-Medium, 3-High

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**Introduction To Forensic Science**		**8**
	1		3

		History of Development of Forensic Science, Functions of forensic science. Definitions and concepts in forensic science, Basic Principles of Forensic Science and its Significance	
	2	Role of forensic science laboratories, Frye case and Daubert standard.	3
	3	Types of forensic Examinations, Organisational set up of Forensic Science Laboratories in India	2
		Book 2-Chapter 1,2 Book1-Chapter 1	
2	**Crime Scene Evidence**		**10**
	1	Physical Evidences Definition, Types, Class and Individual Characteristics	3
	2	Different searching methods for locating physical evidences at scene of crime, Chain of custody	3
	3	Collection, labelling and sealing of evidence, hazardous evidence	2
	4	Reconstruction of crime scene	2
		Book 2-Chapter 3	
3	**Forensic Physics**		**9**
	1	Toolmark evidence, Classification of tool marks. Forensic importance of tool marks, Collection, preservation and matching of tool marks. Restoration of erased serial numbers and engraved marks	3
	2	Glass evidence –Matching of glass samples by mechanical fit and refractive index measurements, Analysis by spectroscopic methods, Fracture analysis and direction of impact	2
	3	Paint evidence –. Analysis by destructive and non-destructive methods. Importance of paint evidence in hit and run cases	2
	4	Fibre evidence – artificial and man-made fibres. Collection of fibre evidence. Identification and comparison of fibres. Soil evidence – importance, location, collection, and comparison of soil samples.	2
		Book 2-Chapter 14,16	

4	**Forensic Ballistics**		**9**
	1	Classification of firearms, weapon types and their operation, country made firearms and regular firearms, calibre, Firing mechanisms of different firearms, Internal, external, and terminal Ballistics	3
	2	Ammunition, Types of ammunition, constructional features and characteristics of different types of cartridges and bullets, primers and priming compounds, projectiles, headstamp markings on ammunition.	3
	3	Firearm Evidence, Matching of bullets and cartridge cases in regular firearms, mechanisms of formation of gunshot residues, methods of analysis of gunshot residues from shooting hands and targets, identification and nature of firearms injuries.	3
		Book 3-Chapters 1,2, Book 4-Chapter 2,3,6	
5	**Teacher Specific Module**		**9**
	Directions:		
	Case study		

Essential Readings:

1. Forensic Science in India: A Vision for the Twenty First Century, B.B. Nanda and R.K. Tiwari, Select Publishers, New Delhi (2001).
2. Forensic Science: An Introduction to Scientific and Investigative Techniques,, S.H. James and J.J. Nordby, 4th Edition, CRC Press, Boca Raton (2005).
3. Handbook of Firearms and Ballistics, B.J. Heard, Wiley and Sons, Chichester (1997).
4. Forensic Ballistics in Criminal Justice, Kaushalendra Kumar, Eastern Book Company, 2015.

Suggested Readings:

1. A Guide to the Recovery and Collection of Physical Evidence,M. Byrd, Crime Scene Evidence: CRC Press, Boca Raton (2001).

2. Handbook of Firearms and Ballistics, B.J. Heard, Wiley and Sons, Chichester (1997).
3. Firearms identification, Forensic Science Handbook, Vol. 2,W.F. Rowe, R. Saferstein (Ed.), Prentice Hall, New Jersey (1988).
4. Role of Forensic Science in the New Millennium, M.K. Bhasin and S. Nath, University of Delhi, Delhi (2002).
5. Fisher's Techniques of Crime Scene Investigation, W.J. Tilstone, M.L. Hastrup and C. Hald, CRC Press, Boca Raton (2013).
6. E. Elaad in Encyclopedia of Forensic Science, Volume 2, J.A. Siegel, P.J. Saukko and G.C. Knupfer (Eds.), Academic Press, London (2000).

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**50**
Continuous Evaluation		**25**
a)	*Test Paper	10
c)	**Assignment/ Book- Article Review	5
d)	Seminar/ Viva -Voce	10
Total		**75**

*Best out of two test papers

** or any other activities like quiz, open book exam, group activity

KU6SECPHY103: Maintenance of Electro-Optical Devices

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VI	SEC	100	KU6SECPHY103	3	45

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture+ Tutorial	Practical	CE	ESE	Total	
3	0	25	50	75	1.5

Course description:

This course aims to develop experience of working with a wide range of laboratory equipments and learn how to test, check faults, and use laboratory equipment.

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the working of various laboratory electrical, electronic, and optical instruments	*U*
2	Identify the fault of electrical devices	*U*
3	Identify fault and do maintenance of electrical-electronic devices	*A*

4	To check the calibration of Oscilloscope & DSO and other electrical equipment. Do the checking and maintenance of equipment.	*An, A*

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	3	3	3	3	2	1
CO 2	1	3	3	2	3	2	1
CO 3	1	3	3	2	3	2	1
CO 4	2	3	3	3	3	2	2
CO 5	1	1	1	1	1	3	3

Correlation level 0-None, 1-Slight, 2-Medium, 3-High

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**Calibration & Testing of Equipment**		**6**
	1	Introduction	1
	2	Calibration of equipments	2
	3	Method of testing and maintenance	2
	4	Different kinds of faults of laboratory equipments	1

2	**Electrical components and measuring devices**		**8**
	1	Checking of Switches, cables and connectors	2
	2	Testing of batteries and fuses, switch box, dual power supply	2
	3	Testing of Measuring devices - Voltmeter, ammeter, galvanometer	2
	4	Testing of multimeter and its various uses	2
3	**Testing of electrical and electronic devices**		**10**
	1	Testing of transformers, inductors, capacitors and resistors	2
	2	Identification of resistors, IC	2
	3	Use of multimeter to check resistance box, resistors	3
	4	Checking of diode, transistor, Zener diode, fuse	3
4	**Calibration and maintenance of electrical, electronic and optical instruments**		**12**
	1	Calibrating and testing cathode ray oscilloscope, digital storage oscilloscope, function generator, potentiometer	3
	2	Maintenance of Spectrometer, telescope, travelling microscope, beam balance, lasers, sodium vapour lamp, mercury vapour lamp, grating	3
	3	Checking and maintenance of Meldey's apparatus, ballistic galvanometer, tangent galvanometer	4
	4	Checking and maintenance of compass box, vibration magnetometer, deflection magnetometer, flywheel, Carey Foster's Bridge	2
5	**Teacher Specific Module**		**9**
	Directions		
	Testing of transformers, inductors, capacitors and resistors; Checking of diode and transistors, calibrating and testing CRO and DSO, function generator.		

Essential Readings:

1. Electronic and Electrical Servicing: Consumer and Commercial Electronics, Second Edn, Ian Sinclair and John Dunton, 2007.
2. Troubleshooting Electronic Equipment: Includes Repair And Maintenance, Second Edn: Dr R.S. Khandpur, 2006.

3. Troubleshooting and Repairing Consumer Electronics Without a Schematic, 3rd Edn, Homer L. Davidson, 2004.
4. How to Diagnose and Fix Everything Electronic, Second Edn, Michael Geier, 2011.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	*Test Paper	10
c)	**Assignment/ Book- Article Review	10
d)	Seminar/ Viva -Voce	10
Total		**100**

*Best out of two test papers

** or any other activities like quiz, open book exam, group activity

DISCIPLINE SPECIFIC COURSES

SEMESTER I

KU1DSCPHY101 : Fundamentals of Physics

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
1	DSC	100	KU1DSCPHY101	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture + Tutorial	Practical	CE	ESE	Total	
3	2	35	65	100	2

Course Description

This course offers a comprehensive introduction to classical mechanics, focusing on Newton's Laws of Motion, work , kinetic energy, potential energy , energy conservation, momentum and collisions. Students will explore fundamental concepts such as force, mass, and inertia, applying Newton's laws to understand equilibrium and dynamics, including friction and fluid resistance. The curriculum covers energy transformations, conservation laws, and the principles of momentum in various collision scenarios. A practical component emphasizes hands-on learning through experiments that illustrate core principles, including the use of modern simulation tools and graph plotting software.

Course Prerequisite: Higher secondary level Physics

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand Newton's laws of motion and their applications in various scenarios	*U*

2	Apply Newton's laws to solve problems related to force, momentum, and energy. Understand the concept of frictional forces and their role in motion of objects	*U, A*
3	Analyse the concepts of work, kinetic-energy, and work energy theorem, Understand the principle of conservation of momentum and apply this to analyse collisions	*U, A*
4	Apply the fundamental principles of physics to solve real world problems	*A*

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs/POs

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**
CO1	3	3	2	3	3	2	0
CO2	3	3	2	3	3	2	0
CO3	3	3	2	3	3	2	1
CO4	3	3	3	3	3	2	0

Correlation level 0-None, 1-Slight, 2-Medium, 3-High

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	**UNIT**	**DESCRIPTION**	**HOURS**
1	**Newton's Laws of Motion**		**15**

	1	Force and Interactions, Superposition of Forces, Newton' First Law, Inertial Frames of References,	3
	2	Newton's Second Law, Mass and Force, Stating Newton's Second law, Using Newton's Second Law, Mass and Weight, Variation of g with Locations, Measuring Mass and Weight, Newton's Third law	4
	3	Using Newton's first Law: Particles in Equilibrium, Using Newton's Second law: Dynamics of Particles, Apparent Weight and Apparent Weightlessness.	4
	4	Friction forces-Kinetic and Static Friction, Rolling Friction, Fluid Resistance and Terminal speed, Dynamics of Circular Motion, Banked Curves and Flight of Airplanes, The fundamental forces of Nature	4
		Sections 4.1-4.5, 5.1-5.5 of Book 1	
2	**Work and Kinetic Energy**		**10**
	1	Work, Work: Positive, Negative or Zero, Total Work, Kinetic Energy and Work Energy Theorem, The meaning of Kinetic Energy, Work and Kinetic Energy in Composite systems	5
	2	Work and Energy with varying forces, work done by a varying force , Straight- Line Motion, Work – Energy Theorem for Straight Line Motion, Varying Forces, Work Energy theorem for Motion along a Curve, Power	5
		Sections 6.1-6.4 of Book1	
3	**Potential Energy and Energy Conservation**		**10**
	1	Gravitational Potential Energy, Conservation of Mechanical Energy, When Force other than Gravity do Work, Gravitational Potential Energy for Motion along a Curved Path, Elastic Potential Energy, Situations with both Gravitational and Elastic Potential energy	6
	2	Conservative and Non-Conservative Forces, The Law of Conservation of Energy, Force and Potential Energy, Energy Diagrams	4
		Sections 7.1 -7.5 of Book1	
4	**Momentum, Impulse and Collisions**		**10**

	1	Momentum and Impulse, Newton's Second Law in terms of Momentum, The Impulse- Momentum Theorem, Momentum and Kinetic Energy Compared, Conservation of Momentum	5
	2	Momentum Conservation and Collisions, Elastic and Inelastic Collisions, Completely Inelastic Collisions, Center of Mass, Rocket Propulsion	5
		Sections 8.1-8.6 of Book 1	
	Practical Module		**30**
	*Directions: **At least 4** experiments from the following + 2 Activities (can be selected from the list or designed by course faculty)*		
	1. Find the moment of inertia of a rod, disc, ring familiarization of Vernier calipers, screw gauge 2. Find the radius of a capillary tube using traveling microscope 3. Spectrometer Angle of the prism 4. Compound pendulum- To find g 5. Activities demonstrating Newton's laws of motion 6. Activities demonstrating friction 7. Activities demonstrating energy conservation 8. Activities demonstrating elastic and inelastic collisions 9. Introduce graph plotting software 10. Simulation experiments using ExpEYES-SEELAB/ Virtual lab/PhET simulations		

Essential Readings:

1. University Physics with Modern Physics – Hugh D Young & Roger A Freedman-14th edition, 2016.

Suggested Readings:

1. Fundamental of Physics -Halliday, Resnick and Walker
2. An Introduction to Mechanics-Kleppner and Kolenkow

Assessment Rubrics:

Evaluation Type			Marks	Evaluation Type			Marks	Total
Lecture			**75**	**Practical**			**25**	**100**
a)	**ESE**		**50**	a)	**ESE**		**15**	
b)	**CCA**		**25**	b)	**CCA**		**10**	
	i	*Test Paper	10		i	Punctuality	3	
	ii	**Assignment/ Book-Article review	10		ii	Skill	4	
	iii	Seminar/ Viva-Voce	5		iii	Record	3	

* Best out of two test papers

** Or any other evaluation technique like quiz, open book exam, group activity

KU1DSCPHY111: Properties of Matter

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
I	DSC	100	KU1DSCPHY111	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture + Tutorial	Practical	CE	ESE	Total	
3	2	35	65	100	2

Course Description

This course introduces Properties of matter which includes topics in elasticity, viscosity, surface tension, and the kinetic theory of gases. Students can explore the principles of stress, strain, and Hooke's law, including the analysis of elastic constants and the behaviour of materials under torsion and bending. The viscosity section covers Bernoulli's theorem, Poiseuille's equation, and Stokes' law, emphasizing the effects of temperature and pressure on fluid viscosity. Surface tension concepts such as molecular forces, surface energy, and capillary action are examined in detail. The kinetic theory of gases is discussed, with a focus on gas laws, molecular velocities, and Van der Waals equation. Laboratory experiments complement theoretical knowledge, offering hands-on experience with a variety of measurement techniques and physical phenomena.

Course Prerequisite: Higher secondary level Physics

Course Outcomes:

CO No.	Expected Outcome	Learning Domains

1	Understand the concepts of load, stress, and strain, including Hooke's law and stress-strain diagrams.	*U*
2	Understand different types of elasticity and analyse material behaviour and structural mechanics	*U, An*
3	Understand how fluids flow and behave under different conditions, and the properties of gases. Apply these principles to real-world situations in engineering and science.	*U, A*
4	Apply the basic principles regarding properties of matter and develop practical skills in measurement techniques and data analysis.	*A*

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	3	2	3	3	2	1
CO 2	3	3	2	3	3	2	1
CO 3	3	3	2	3	3	2	0
CO 4	3	2	1	2	3	2	1
CO 5	3	3	3	3	3	2	1

****Correlation level 0-None, 1-Slight, 2-Medium, 3-High***

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**Elasticity**		**14**
	1	Elasticity, Stress and Strain, Hooke's law, Behaviour a wire under increasing load, Youngs modulus, Bulk modulus, Isothermal and adiabatic elasticity of a gas, Modulus of rigidity, Poisson's ratio.	4
	2	Relation connecting various elastic constants Y, K, η, σ (Derivation not required), Limiting values of σ . Work done per unit volume in a deforming body.	4
	3	Angle of twist and angle of shear, twisting couple on a cylindrical rod or wire, work done in twisting a wire or rod, Determination of modulus of rigidity dynamically- torsional pendulum	4
	4	Bending of beams, bending moment, Beam supported at its ends and loaded in the middle (Non-uniform bending)	2
		Sections 12.1- 12.10, 12.12-12.17, 12.18 (3a), 12.20, 12.23 Book 1	
2	**Hydrodynamics and Viscosity**		**10**
	1	Streamline and Turbulent flows, Tubes of flow and equation of continuity	2
	2	Energy possessed by a liquid, Bernoulli's theorem	3
	3	Viscosity, critical velocity, flow of liquid through a capillary tube-Poiseuille's formula	3
	4	Stoke's formula, Variation of viscosity with temperature , Viscosity of gases.	2
		Sections 14.1-14.4, 15. 1-15.3, 15.6, 15.11, 15.13, Book1	
3	**Surface tension**		**10**

	1	Molecular forces, Free surface of a liquid tends to contract to smallest possible area, Surface tension, surface energy, shape of drops	3
	2	Pressure difference across a curved surface, Expression for excess pressure on a curved surface - excess pressure inside spherical drop, air bubble and soap bubble	4
	3	Shape of liquid meniscus in a capillary tube, angle of contact, capillary action	3
		Sections 16.1-16.6, 16.9-16.13, 16.17, 16.18, 16.21 Book 1	
4	**Kinetic theory of gases**		**11**
	1	Kinetic theory of gases, pressure exerted by a perfect gas, root mean square velocity, deduction of gas laws on the basis of the kinetic theory	4
	2	Boyle's law, Avogadro's hypothesis, Graham's law of diffusion	3
	3	Kinetic energy of a molecule, value of the gas constant, Van der Waal's equation, mean free path of a molecule.	4
		Sections 15.1 - 15.10 Book 2	
5	**Practical Module**		**30**
	*Directions: **AT least 4** experiments from the list and 2 experiments /activities* designed by course faculty		
	1. Find the moment of inertia of a rod, disc, ring- familiarisation of vernier callipers, screw gauge 2. Find the angle of a prism using spectrometer 3. Find the radius of a capillary tube using travelling microscope 4. Determine Moment of inertia of a flywheel 5. Young's modulus of the material of the bar - Uniform bending using optic lever 6. Determine resistance and resistivity of given wire using potentiometer 7. Determine rigidity modulus of a wire using torsion pendulum 8. Coefficient of viscosity - Poiseuille's formula 9. Determine Refractive index of a liquid and material of the lens		

	using mercury by liquid lens arrangement	

Essential Readings:

1. Mechanics - Oscillations and Properties of Matter, J C Upadhyaya, Ram Prasad Publications, 2017.
2. Elements of properties of matter, D.S. Mathur, 11 th Edn., S. Chand & Company Ltd, 2007.

Suggested Readings:

1. A Treatise on General Properties of Matter - Chatterjee & Sengupta, New Central Book Agency (P) Limited, 2011.
2. Properties of matter, Brijlal and N Subramanyam, Eurasia Publishing House Limited, 1993.

Assessment Rubrics:

Evaluation Type			**Marks**	**Evaluation Type**			**Marks**	**Total**
Lecture			**75**	**Practical**			**25**	**100**
a)	**ESE**		**50**	a)	**ESE**		**15**	
b)	**CCA**		**25**	b)	**CCA**		**10**	
	i	*Test Paper	10		i	Punctuality	3	
	ii	**Assignment/ Book-Article review	10		ii	Skill	4	
	iii	Seminar/ Viva-Voce	5		iii	Record	3	

*Best out of two test papers

** or any other activities like quiz, open book exam, group activity

KU1DSCPHY112: Basic Mechanics

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
I	DSC	100	KU1DSCPHY112	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture+ Tutorial	Practical	CE	ESE	Total	
3	2	35	65	100	2

Course Description

Basic Mechanics is an introductory course exploring the fundamental principles of classical mechanics. Students will learn about forces, motion, energy, rotational dynamics, gravitation through theoretical lessons and practical experiments . The course emphasizes problem-solving skills and real-world applications.

Course Prerequisite: Higher secondary level Physics

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand and apply Newton's laws to analyse forces and motion in various physical systems.	*U,A*
2	Apply principles of work, energy, and momentum to solve problems involving conservation laws and collisions.	*A*
3	Analyse rotational motion, including angular kinematics and dynamics, and apply concepts such as torque and angular momentum	*An, A*

4	Examine gravitational interactions and the motion of celestial bodies using Newton's law of gravitation and Kepler's laws	*E*
5	Understand the foundations of relativity, including the invariance of physical laws and the relativistic effects on time, length, and simultaneity.	*U, An*

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	3	2	3	3	2	1
CO 2	3	3	2	3	3	2	1
CO 3	3	3	2	3	3	2	1
CO 4	3	2	1	3	3	2	0
CO 5	3	2	1	3	3	2	1

Correlation level 0-None, 1-Slight, 2-Medium, 3-High

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION		HOURS
1		**Newton's Laws and Applications**		12
	1	Force and Interactions , Newton's First Law, Newton's Second Law, Mass and Weight, Newton's Third Law, Free-Body Diagrams		6
	2	Particles in Equilibrium, Dynamics of Particles, Frictional Forces, Dynamics of Circular Motion, The Fundamental Forces of Nature		6
		Sections 4.1 – 4.6, 5.1-5.5 Book 1		
2		**Momentum, Energy and Conservation Laws**		12
	1	Work, Kinetic Energy and Work–Energy Theorem, Power, Gravitational Potential Energy-conservation of mechanical energy, Elastic Potential Energy-gravitational potential energy versus elastic potential energy, Conservative and Nonconservative Forces, law of conservation of energy, Force and Potential Energy		6
	2	Momentum and Impulse-Newton's second law in terms of momentum, Conservation of Momentum, Momentum Conservation and Collisions- Elastic and inelastic collisions, Center of Mass-position vector, and motion of centre of mass.		6
		Sections 6.1-6.2,6. 4, 7.1-7.4, 8.1-8.5 Book 1		
3		**Rotational Dynamics**		12
	1	Angular velocity and acceleration, Rotation with constant angular acceleration, Relating linear and angular kinematics, Energy in rotational motion-computing moment of inertia(rod, ring, disc), Parallel-axis Theorem		6
	2	Torque, Torque and angular acceleration for a rigid body, rigid-body rotation about a moving axis-combined translation and rotation energy relationship.		4

	3	Angular momentum, Conservation of angular momentum		2
		Sections 9.1-9.5, 10.1- 10.3, 10.5, 10.6, Book 1		
4	**Gravitation**			9
	1	Newton's law of Gravitation, Weight, Gravitational Potential Energy		3
	2	The motion of satellites, Kepler's Laws, and the motion of planets		4
	3	Black Holes (Qualitative idea)		2
		Sections 13.1-13.5, 13.8, Book 1		
5	**Practical Module**			**30**
	Directions : **At least 4** experiments from the following + 2 Activities (can be selected from the list or designed by course faculty.)			
	1. Find the moment of inertia of a rod, disc, ring- familiarisation of Vernier callipers, screw gauge 2. Find the radius of a capillary tube using travelling microscope 3. Determine angle of the prism using spectrometer 4. Determine the refractive index of a liquid and material of the lens using mercury by forming liquid lens arrangement 5. Determine moment of inertia of a disc using it as torsion pendulum 6. Determine resistance and resistivity of a wire using potentiometer 7. Determine g using compound pendulum 8. Simulation experiments using expEYES-SEElab/ Amrutha V lab/PhET simulations 9. Introduce graph plotting software			

Essential Readings:

1. University Physics with Modern Physics, , Hugh D. Young, Roger A. Freedman, 14th Edition, 2016.

Suggested Readings:

1. An introduction to mechanics, D. Kleppner, R. J. Kolenkow, McGraw-Hill, 2014.

2. Mechanics, Berkeley Physics, Vol.1, C. Kittel, W. Knight, et.al. , Tata McGraw-Hill, 2007.
3. Physics, Resnick, Halliday and Walker 8/e., Wiley, 2008.
4. Analytical Mechanics, G. R. Fowles and G. L. Cassiday, Cengage Learning, 2005.
5. Feynman Lectures, Vol. I, R. P. Feynman, R. B. Leighton, M. Sands, Pearson Education, 2008.
6. Introduction to Special Relativity, R. Resnick, John Wiley and Sons, 2005.
7. University Physics, Ronald Lane Reese, Thomson Brooks/Cole, 2003.
8. Mechanics, D. S. Mathur, S. Chand and Company Limited, 2000.
9. Physics for scientists and Engineers with Modern Phys., J. W. Jewett, R. A. Serway,, Cengage Learning, 2010.
10. Theoretical Mechanics, M. R. Spiegel, Tata McGraw Hill, 2006.

Assessment Rubrics:

Evaluation Type			**Marks**	**Evaluation Type**			**Marks**	**Total**
Lecture			**75**	**Practical**			**25**	**100**
a)	**ESE**		**50**	a)	**ESE**		**15**	
b)	**CCA**		**25**	b)	**CCA**		**10**	
	i	*Test Paper	10		i	Punctuality	3	
	ii	**Assignment/ Book-Article review	10		ii	Skill	4	
	iii	Seminar/ Viva-Voce	5		iii	Record	3	

*Best out of two test papers

** or any other activities like, quiz, open book exam, group activity

KU1DSCPHY113: Introduction to Astrophysics

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
1	DSC	100	KU1DSCPHY113	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture + Tutorial	Practical	CE	ESE	Total	
3	2	35	65	100	2

Course Description

The course aims to develop an understanding the basics of Astronomy, Astrophysics and Cosmology with the underlying physical concepts. Also, the students can get the idea of different types of Astronomical objects and their morphological and physical properties and physical process going on. The course provides the basics about the origin and large-scale structure of the universe and its properties. In short, the course provides a good platform to understand and carry forward the studies to higher levels.

Course Prerequisite: Higher secondary level Physics

Course Outcomes:

CO No.	Expected Outcome	Learning Domains

1	Understand the basic tools used in Astronomy and the spectral classification of stars	R, U
2	Explore the stellar evolution.	U
3	Analyse the structure the sun and various solar phenomena, classification of galaxies based on its morphological properties	An
4	Understand the theories on origin, evolution and future of the universe	U
5	Apply the measuring techniques and basic ideas of Astronomy	A

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	2	2	2	3	2	1
CO 2	3	2	1	3	3	2	1
CO 3	3	2	2	3	3	2	1
CO 4	3	2	1	3	3	2	1
CO 5	3	2	3	3	3	2	0

****Correlation level 0-None, 1-Slight, 2-Medium, 3-High***

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
	Basic Tools of Astronomy		**12**
	1	Angular Measurement, Distances in Astronomy, Brightness and Luminosity of Astronomical Objects, Magnitudes	4
	2	The Colour of Stars, The Sizes of Stars-Flux, Luminosity and Radius, Stellar Classification, Redshift and Blueshift	4
	3	Hertzsprung-Russel Diagram, The H-R Diagram and Stellar Radius, H-R Diagram and Stellar Luminosity, H-R Diagram and Stellar Mass.	4
	4	**Book 1-Sections 1.1 to 1.4, 1.6,1.7 3.2,3.4, 4.1 to 4.4**	
2	**Stellar Evolution**		**14**
	1	Introduction-Interstellar medium, Molecular Clouds, Protostars, The Birth of a Star, Pre-Main Sequence Evolution and the Effect of Mass, Lifetimes of Main Sequence Stars, Red Giant Stars, Helium Burning and the Helium Flash.	5
	2	The Death of Stars, The Asymptotic Giant Branch, Dredge-Ups, Mass Loss and Stellar Winds, Infrared Stars, The End of an AGB Star‘s Life, White Dwarf Stars-The Chandrasekhar Limit,	4
	3	High-Mass Stars and Nuclear Burning, Supernovae and the Formation of Elements, Neutron Stars and Pulsars, Black Hole Basics, The Singularity, Event Horizon	5
		Book 1-Sections 5.1, 5.6, 5.7, 6.1, 6.2, 10.1,10.2, 10.3, 11.1-11.6, 11.8.1, 11.8.2, 12.1, 12.2, 12.6, 14.1 to 14.3	

3	**The Sun and Galaxies**		**10**
	1	The structure of the Sun - From the Core to Surface, The Proton-Proton Chain, Sunspots - The Solar Cycle, The Solar Magnetic Cycle, Prominences, Flares, Coronal Mass Ejections and the Solar Wind.	5
	2	Galaxy Types, Galaxy Structure, Stellar Populations, Hubble Classification of Galaxies, The Milky Way,	5
		Book 1-Sections 8.1 ,8.2, 8.4.1,8.4.3, 8.5, 16.1 to 16.5, 16.7	
4	**Introduction to Cosmology**		**9**
	1	The Big Bang, Hubble's law, Evolution after the Big Bang, Evidence for and Against the Big Bang Theory,	5
	2	The Inflationary Model-CMBR, Horizon problem and flatness problem.	4
		Book 1-Sections 18.1 ,18.2, 18.3, 18.4, 18.5.2, 18.5.3	
5	**Practical Module**		**30**
	*Directions: **AT least 4** experiments from the list and 2 experiments /activities designed by the course faculty*		
	1. Find the moment of inertia of a rod, disc, ring- familiarisation of Vernier callipers, screw gauge 2. Find the radius of a capillary tube using travelling microscope 3. Determine angle of the prism using spectrometer 4. Determine the refractive index of a liquid and material of the lens using mercury by forming liquid lens arrangement 5. Determine moment of inertia of a disc using it as torsion pendulum 6. Determine resistance and resistivity of a wire using potentiometer 7. Determine g using compound pendulum 8. Stellarium-familiarisation and applications 9. Sky watch		

Essential Readings:

1. **Astrophysics Is Easy!** An Introduction for the Amateur Astronomer By Mike Inglis (3rd Edn) , The Patrick Moore Practical Astronomy Series 2023.

Suggested Readings:

1. Understanding our Universe (4 Edn) by Stacy Palen and Georg Blumenthal, 2021.
2. An introduction to Modern Astrophysics, B. W. Carroll & D. A. Ostlie, Addison-Wesley Publishing Co. , 2017.
3. Introductory Astronomy and Astrophysics, M. Zeilik and S. A. Gregory, Saunders College Publishing, 2022.
4. The physical universe: An introduction to astronomy, F. Shu, Mill Valley: University Science Books, 1982.
5. Fundamentals of Astronomy (Fourth Edition), H. Karttunen et al. Springer, 2003.
6. Astro Physics a modern perspective-K. S. Krishnasamy, (New Age International (P) Ltd, 2002.
7. An introduction to Astrophysics - Baidyanath Basu, (Prentice-Hall of India Private limited, 2001.
8. **Turn Left at Orion -** Hundreds of night sky objects to see in a home telescope – and how to find them (4Edn) Guy Consolmagno and Dan M. Davis, 2011.

Assessment Rubrics:

Evaluation Type			**Marks**	**Evaluation Type**			**Marks**	**Total**
Lecture			**75**	**Practical**			**25**	**100**
a)	**ESE**		**50**	a)	**ESE**		**15**	
b)	**CCA**		**25**	b)	**CCA**		**10**	
	i	*Test Paper	10		i	Punctuality	3	
	ii	**Assignment/ Book-Article review	10		ii	Skill	4	
	iii	Seminar/ Viva-Voce	5		iii	Record	3	

*Best out of two test papers

** or any other activities like quiz, open book exam, group activity

KU1DSCPHY114: Electricity and Magnetism

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
I	DSC	100	KU1DSCPHY114	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture+ Tutorial	Practical	CE	ESE	Total	
3	2	35	65	100	2

Course Description:

This course covers the fundamental principles and mathematical formalism related to static electric and magnetic fields as well as electric current. Students can verify the fundamental laws of electricity and magnetism through laboratory experiments.

Course Prerequisite: Higher secondary level Physics

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the fundamental concepts of electric charge, conductors, insulators, and induced charges,	*U*
2	Understand coulomb's law and apply it to determine electric force and field	*U, A*
3	Understand Gauss's law and apply it to determine electric field due to different charge distributions	*U, A*
3	Understand magnetism, magnetic field properties, magnetic flux, and l analyse the force and torque on current loops	*U, An*
4	Understand and apply Ampere's circuital law to determine magnetic field due to current distribution	*U, A*

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	2	1	2	3	2	1
CO 2	3	2	0	2	3	2	0
CO 3	3	2	1	2	3	2	1
CO 4	3	2	2	3	3	2	1

Correlation level 0-None, 1-Slight, 2-Medium, 3-High

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**Electric Charge and Electric Fields**		**12**
	1	Electric charge ,Conductors, insulators and induced charges	3
	2	Coulomb’s law - Electric field and electric forces - Electric field calculations - Electric field lines , Electric dipole	3
	3	Charge and electric flux- Calculating electric flux, Gauss’s law- point charge inside a spherical surface	3
	4	Applications of Gauss’s law- Field due to point charge, charged hollow sphere, Charge on conductors	3
		Sections: 21.1 - 21.7, 22.1 - 22.5	
2	**Electric potential**		**10**
	1	Electric potential energy - Electric potential, Equipotential surfaces	3
	2	Capacitors and capacitance, capacitors in series and parallel	3
	3	Current - Resistivity - Resistance	2

	4	Electromotive force and circuits - Energy and power in electric circuits.	2
		Sections: 23.1 -23.2, 23.4, 24.1, 25.1 - 25.5	
3	**Magnetic field and magnetic forces**		**12**
	1	Magnetism, Magnetic field - Magnetic field lines and magnetic flux	4
	2	Motion of charged particle in a magnetic field, Magnetic force on a current carrying conductor -	4
	3	Force and torque on a current loop- The direct current motor	4
		Sections: 27.1 - 27.4, 27.6 - 27.8	
4	**Sources of magnetic field**		**11**
	1	Magnetic field of a moving charge - Magnetic field of a current element	2
	2	Magnetic field of a straight current carrying conductor - Force between parallel conductors	3
	3	Magnetic field of a circular current loop	2
	4	Ampere's law - Applications of Ampere's law	4
		Sections: 28.1 - 28.7	
5	**Practical Module**		**30**
	Directions : **At least 4** experiments from the following + 2 Activities (can be selected from the list or designed by course faculty)		
	1. Find the moment of inertia of a rod, disc, ring familiarisation of Vernier callipers, screw gauge 2. Find the radius of a capillary tube using travelling microscope 3. Determine angle of the prism using spectrometer 4. Determine resistance and resistivity of given wire using potentiometer 5. Find the current sensitivity of a galvanometer. 6. Forward and reverse characteristics of pn junction diode. 7. Half wave rectifier using a diode. Study ripple factor with and without filter. 8. Simulational Experiments in electricity and magnetism using PhET		

	simulations / Amritha V-lab simulations	

Essential Readings:

1. University physics with modern physics, 14th edition, Young & Freedman, 2016.

Suggested Readings:

1. Fundamentals of Physics, Halliday, Resnick and Walker, John Wiley &Sons, 2011.
2. Practical Physics, P. R. Sasikumar, PHI Learning Pvt Limited, 2011.

Assessment Rubrics:

Evaluation Type			**Marks**	**Evaluation Type**			**Marks**	**Total**
Lecture			**75**	**Practical**			**25**	**100**
a)	**ESE**		**50**	a)	**ESE**		**15**	
b)	**CCA**		**25**	b)	**CCA**		**10**	
	i	*Test Paper	10		i	Punctuality	3	
	ii	**Assignment/ Book-Article review	10		ii	Skill	4	
	iii	Seminar/ Viva-Voce	5		iii	Record	3	

*Best out of two test papers

** or any other activities like ,quiz, open book exam, group activity

KU1DSCPHY115:Semiconductor Physics and Electronics

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
1	DSC	100	KU1DSCPHY115	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture+ Tutorial	Practical	CE	ESE	Total	
3	2	35	65	100	2

Course Description:

This course offers an introduction to semiconductor physics, including the properties and behaviour of semiconductors, diodes, and transistors. Students will learn about pn junctions, diode rectifiers, transistor biasing, and various types of transistor amplifiers and oscillators. Practical laboratory sessions will reinforce theoretical concepts, focusing on diode characteristics, rectifier circuits, voltage regulation, and amplifier and oscillator designs.

Course Prerequisite: Higher secondary level Physics

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the concept of energy bands in solids .	*R, U*
2	Understand the principle and applications of PN junction diode , Zener diode and LEDs	*U, A, An*
3	Understand the structure, operations, characteristics of transistor	*R, U*
4	Analyse the characteristics of various transistor configurations and application of BJT as amplifier	*A, An*

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	2	1	2	3	2	1
CO 2	3	2	2	2	3	2	1
CO 3	3	2	2	3	3	2	1
CO 4	3	2	3	3	3	2	1

Correlation level 0-None, 1-Slight, 2-Medium, 3-High

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**Introduction to Electronics and Energy bands**		**10**
	1	Electronics, Atomic structure, Structure of elements, The Electron, energy of an electron , valence electrons, free electron	**2**
	2	Voltage source, constant voltage source, constant current source	**2**
	3	Bohr atom model, energy levels and energy bands	**3**
	4	Important energy bands in solids, classification of solids and energy bands, silicon	**3**

	Section 1.1-1.10, 4.1-4.6 of Book 1		
2	**Semiconductor Physics**		**12**
	1	Semiconductor, Bonds in semiconductor, commonly used semiconductors, Energy band description of semiconductors, Effect of temperature on semiconductors, Hole current,	3
	2	Intrinsic semiconductor, n-type semiconductor, p-type semiconductor, charge on n-type and p-type semiconductor, majority, and minority carriers	3
	3	pn junction, Properties of pn junction, Biasing a pn junction, Current flow in a forward biased pn junction	3
	4	Voltage – Ampere characteristics of pn junction and important terms and limitation in the operating condition of pn junction.	3
		Book 1, Sections 5.1 to 5.20	
3	**Semiconductor Diode**		**12**
	1	Semiconductor diode, Crystal diode rectifier, resistance of crystal diode, important terms	2
	2	Half wave rectifier, Output frequency of Half –wave rectifier, efficiency of half wave rectifier	2
	3	Full wave rectifier, Centre - tap full wave rectifier, Full wave bridge rectifier, output frequency of full wave rectifier and efficiency of full wave rectifier, Ripple factor, Comparison of rectifiers	5
	4	Zener diode, Zener diode as voltage stabilizer, LED-LED voltage and current, advantages of LED, multi coloured LED, applications of LED	3
		Book 1, Sections 6.1-6.3, 6.6, 6.7 – 6.15, 6.18 - 6.19, 6.25 – 6.27,7.2-7.4	
4	**Transistors and transistor biasing**		**11**
	1	Transistor, naming the transistor terminals, some facts about transistor, transistor action, transistor symbols	2

	2	Transistor connection, Common base connection, Characteristics of common base connection, Common emitter connection, Characteristics of common emitter connection, Common collector connection	4
	3	Comparison of Transistor connections , commonly used transistor connection, Transistor as an amplifier in CE arrangement	5
	Book 1, Sections 8.1 – 8.10, 8.12 –8.16		
5	**Practical Module**		**30**
	Directions: Any 4 experiments from the list plus 2 experiments designed by course faculty		
	1. Familiarization of electronic components-resistors, diodes, capacitors, transistors, colour code of resistors 2. Determine resistance and resistivity of a wire using potentiometer 3. Find the radius of a capillary tube using travelling microscope 4. Determine angle of the prism using spectrometer 5. Forward and reverse characteristics of pn junction diode. 6. Half wave rectifier using a diode. Study ripple factor with and without filter. 7. Reverse characteristics of Zener diode 8. Experiments using LEDs		

Essential Readings:

1. Principle of Electronics, V K Metha and Rohith Mehtha, 11th Edn, S Chand & Company, 2019.

Suggested Readings:

1. Electronic Devices, 9th Edition ,Thomas L Floyd (Pearson), 2012.
2. Electronic Devices and Circuits, David A Bell, 5th Edn. 2009.
3. Electronic Devices and circuit theory, 11th Edn Robert L Boylestad & Louis Nashelsky Pearson Education, 2015.
4. Electronic Principles - A P Malvino (TMH), 2006.
5. Basic Electronics and Linear Circuits NN Bhargava, DC Kulshreshtha and SC Gupta (Mc Graw Hill)

Assessment Rubrics:

Evaluation Type			Marks	Evaluation Type			Marks	Total
Lecture			**75**	**Practical**			**25**	**100**
a)	**ESE**		**50**	a)	**ESE**		**15**	
b)	**CCA**		**25**	b)	**CCA**		**10**	
	i	*Test Paper	10		i	Punctuality	3	
	ii	**Assignment/ Book-Article review	10		ii	Skill	4	
	iii	Seminar/ Viva-Voce	5		iii	Record	3	

*Best out of two test papers

** or any other activities like quiz, open book exam, group activity

KU1DSCPHY116: Introduction to Computational Physics

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
I	DSC	100	KU1DSCPHY116	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture+ tutorial	Practical	CE	ESE	Total	
3	2	35	65	100	2

Course Description:

The course covers the fundamentals of Python programming and its application in elementary Mechanics.

Course Prerequisite: Higher secondary level Computer Science

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Apply Python programming to solve elementary mechanics problems, analysing data sets, and plotting functions	*A*
2	Understand standardized units, conversion between units, and interpret numerical representations	*U*
3	Analyse motion in one dimension using Python, including modelling scenarios such as the motion of a falling tennis ball and calculate key motion parameters.	*An ,A*
4	Understand the fundamental principles of forces in one dimension according to Newton's laws of motion. and apply these principles to analyse different force models	*U, A*

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	2	3	1	2	3	2	1
CO 2	3	2	2	1	2	1	1
CO 3	3	3	2	3	3	1	1
CO 4	3	2	2	2	3	2	1

Correlation level 0-None, 1-Slight, 2-Medium, 3-High

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**Introduction to Computational Physics with Python**		**12**
	1	Physics – Mechanics - Integrating Numerical Methods – Problems and Exercises – How to Learn Physics	2
	2	A Python Calculator - Scripts and Functions	2
	3	Plotting Data-Sets - Plotting a Function - Random Numbers	4
	4	Conditions - Reading Real Data – Plot of Function and Derivatives	4
		Book 1 Sections: 1.1 – 2.7	
2	**Units, Uncertainty, and Numerical Representation**		**10**
	1	Standardized Units	2
	2	Changing Units	2
	3	Uncertainty and Significant Digits	3
	4	Numerical Representation	3
		Book 1 Sections: 3.1 – 3.4	

3	**Kinematics and Dynamics: Modelling Motion**		**10**
	1	Description of Motion	2
	2	Motion of a Falling Tennis Ball	2
	3	Calculation of Motion	3
	4	Modelling the Motion of a Falling Tennis Ball	3
		Book 1 Sections: 4.1 – 4.2	
4	**Forces and Newton's Laws of Motion**		**13**
	1	Forces on One Dimension – Newton’s Second Law of Motion	5
	2	Force Models: Gravitational Force, Viscous Force	5
	3	Newton’s First Law	1
	4	Newton’s Third Law	2
		Book 1 Sections: 5.1 – 5.9	
5	**Practical Module**		**30**
	Directions: **At least 4** from the following + 2 Activities (can be selected from the list or designed by the teacher.		
	1. Find the moment of inertia of a rod, disc, ring- familiarisation of Vernier callipers, screw gauge 2. Find the radius of a capillary tube using travelling microscope 3. Determine angle of the prism using spectrometer 4. Determine resistance and resistivity of a wire using potentiometer 5. Write a simple python script to convert Hours into seconds and use the script to find the number of seconds in 1.5, 12 and 24 h. 6. Generate a basic line graph, scatter plot and bar chart for a given set of x and y values. 7. Plot a sine wave using markers +, o and x using three different colours. 8. Write a script that calculates the mass of a sphere given its radius r and mass density ρ and use the script to find the mass of a sphere of steel of radius r = 1mm, r = 1m, and r = 10 m. 9. Make a function fvalue(x,n) which returns the value of f (x, n). Use this function to plot $1/x$, $1/x^2$ and $1/x^3$ in the same plot for $-1 < x < 1$.		

	10. Write a Python program to print the multiplication table of 5 using while loop.	

Essential Readings:

1. Elementary Mechanics Using Python: A Modern Course Combining Analytical and Numerical Techniques, Anders Malthe-Sørenssen, Springer International Publishing Switzerland, 2015

Suggested Readings:

1. Scientific Computing in Python - Abhijith Kar Gupta (2nd Edition), 2021.
2. Python for Informatics - Charles Severance, 2013.
3. Python for Education - Ajith Kumar B.P. Numerical Methods in Engineering with Python 3 - Jaan Kiusalaas, 2010.

Assessment Rubrics:

Evaluation Type			**Marks**	**Evaluation Type**			**Marks**	**Total**
Lecture			**75**	**Practical**			**25**	**100**
a)	**ESE**		**50**	a)	**ESE**		**15**	
b)	**CCA**		**25**	b)	**CCA**		**10**	
	i	*Test Paper	10		i	Punctuality	3	
	ii	**Assignment/ Book-Article review	10		ii	Skill	4	
	iii	Seminar/ Viva-Voce	5		iii	Record	3	

*Best out of two test papers

** or any other activities like quiz, open book exam, group activity

KU1DSCPHY117: Molecular & Radiation Biophysics

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
1	DSC	100	KU1DSCPHY117	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture+ Tutorial	Practical	CE	ESE	Total	
3	2	35	65	100	2

Course Description:

This course offers a foundational understanding of Molecular Biophysics, focusing on the physical principles that govern the behaviour of biological macromolecules. It explores the relationship between structure and function, the tools used in molecular investigations, and the relevant time and length scales in biology. Students will study the forces that drive molecular interactions, the behaviour of macromolecules in various environments, and the application of isotopes in biological research and clinical diagnostics. Emphasis is placed on thermodynamics, spectroscopy, and radiation-based techniques, equipping students with both conceptual and practical insights into modern biophysical methods.

Course Prerequisite: Higher secondary level Physics

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand and apply physical principles such as thermodynamics, hydrodynamics, and spectroscopy to explain the structure and function of biological macromolecules at molecular and cellular scales.	*R, U, A*
2	Analyse the behaviour of macromolecules in solution, including their interactions with the environment through	*R, U*

	concepts like chemical potential, colligative properties, osmotic pressure, etc.	
3	Evaluate the nature and role of molecular forces, including electrostatic, covalent, and intermolecular interactions, in biological systems using theoretical models and physical laws.	*R, U*
4	Demonstrate knowledge of isotopes and their applications in biology and medicine, including tracer techniques, clinical diagnostics, therapeutic uses, and the associated safety protocols.	*R, U, A, An*

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	1	1	3	3	3	3	1
CO 2	2	1	2	3	3	2	1
CO 3	2	1	3	3	3	2	2
CO 4	1	1	3	3	3	3	3

Correlation level 0-None, 1-Slight, 2-Medium, 3-High

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**Introduction to Molecular Biophysics**		**10**
	1	Introduction to molecular biophysics, A brief history and perspectives	2

	2	Languages and tools, Length and time scales in biology, The structure-function hypothesis	2
	3	Complementarity of physical methods, Thermodynamics, Hydrodynamics, Radiation scattering	2
	4	Spectroscopy, Single-molecule detection	4
	Sections from the Introduction Module of Book 1		
2	**Macromolecules in Their Environment**		**9**
	1	Historical review, Macromolecular solutions	1
	2	Concentration, Partial volume, Colligative properties, Chemical potential and activity	3
	3	Temperature, Osmotic pressure, Virial coefficients	2
	4	Ionic strength and Debye-Huckel theory, Polyelectrolytes and the Donnan effect.	3
	Sections A1.1, A1.2, A1.2.1, A1.2.2, A1.2.3, A1.2.4, A1.2.5, A1.2.6, A1.2.7, A1 .3.1, A1.3.2 of Book 1		
3	**The Forces between Atoms and Molecules**		**12**
	1	The four forces of nature, Greek and medieval notions of intermolecular forces	2
	2	Intermolecular force-laws and interaction potentials: Long- and short-range forces	2
	3	Covalent or chemical bonding forces, Physical and chemical bonds. Coulomb forces or charge-charge interactions, Gauss's law	4
	4	Ionic crystals, Reference states, Range of electrostatic forces.	4
	Sections 1.1, 1.2, 1.6, 3.1, 3.2, 3.3, 3.4, 3.5, 3.6 of Book 2		
4	**Isotopes in Biology**		**14**
	1	What is an isotope?, What is radioactivity?, Radioactive decay	2
	2	Radioactive decay energy, Rate of radioactive decay, Units of radioactivity	3
	3	Uses of isotopes as tracers in biological sciences: Distribution studies, Isotope dilution studies	3
	4	Clinical applications: Diagnosis, Therapy, Radioisotopes in sterilization of foods and equipments, Radioimmunoassay, Immunoradiometry, Other	6

	uses, Study of protein structure, Safety aspects, Precautions, Accidental ingestion of radio-isotopes.	
	Sections from Chapter 13 of Book 3	
5	**Practical Module**	**30**
	Directions: **Any 4** experiments from the list + 2 experiments designed by course faculty	
	1. Liquid lens - Refractive index of a liquid and material of the lens using another liquid of known refractive index. 2. Compound pendulum- radius of gyration. 3. Determine angle of the prism using spectrometer. 4. Deflection Magnetometer –Tan A and Tan B . 5. Determine resistance and resistivity of a wire using potentiometer. 6. Find the radius of a capillary tube using travelling microscope. 7. Make different molar solutions of different samples and form different concentration by serial dilution method. 8. Introduce graph plotting software. 9. Simulations-Structural elucidation of simple molecules by analysing IR spectrum, Spectral analysis of UV-Vis spectrum.	

Essential Readings:

1. *Methods in Molecular Biophysics: Structure, Dynamics, Function* by Igor N. Serdyuk, Nathan R. Zaccai, Joseph Zaccai (Cambridge University Press).
1. *Intermolecular and Surface Forces* (Third Edition) By Jacob N. Israelachvili. Academic Press, Elsevier.
2. *Biophysical Chemistry: Principles and Techniques*. By Avinash Upadhyay, Kakoli Upadhyay, Nirmalendu Nath- Himalaya Publishing House.

Suggested Readings:

1. *Introduction to Molecular Biophysics*, By Jack Tuszynski and Michal Kurzynski (CRC Press).
2. *Physical Chemistry for the Life Sciences*, By Peter Atkins and Peter Atkins (Oxford University Press).
3. *Atoms, Radiation, and Radiation Protection*, By James E. Turner (Wiley-VCH).

Assessment Rubrics:

Evaluation Type			Marks	Evaluation Type		Marks	Total
Lecture			**75**	**Practical**		**25**	**100**
(a)	**ESE**		**50**	**(a)**	**ESE**	**15**	
(b)	**CCA**		**25**	**(b)**	**CCA**	**10**	
	i	*Test Paper	10	i	Punctuality	3	
	ii	**Assignment/ Book Article review	10	ii	Skill	4	
	iii	Seminar/ Viva-Voce	05	iii	Record	3	

*Best out of two test papers

**or any other activities like quiz, open book exam, group activity.

SEMESTER II

KU2DSCPHY102: Physics of Solids and Fluids

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
II	DSC	100	KU2DSCPHY102	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture+ Tutorial	Practical	CE	ESE	Total	
3	2	35	65	100	2

Course Description:

This course explores fundamental concepts in mechanics and fluid dynamics, covering topics such as moment of inertia, elasticity, viscosity, and surface tension. Students will learn about the physical significance of moment of inertia, stress-strain relationships, fluid flow principles including Bernoulli's theorem, and surface tension phenomena. Practical applications and experiments will enhance understanding of these concepts, facilitating the analysis of mechanical systems and fluid behaviour in various real-world scenarios.

Course Prerequisite: Higher secondary level Physics

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the concept of moment of inertia and its physical significance	*U*
2	Understand the concepts of load, stress, and strain, including Hooke's law and stress-strain diagrams .	*U*

3	Understand different types of elasticity and apply them to experimentally determine modulus of elasticity for different materials	*U,An*
3	Analyse the flow of fluids and their behaviour under different conditions	*U,A*
4	Understand molecular forces, surface tension and analyse the behaviour of drops and bubbles.	*U,A*
5	Develop skill in conducting and analysing experiments	A, An

Remember I, Understand (U), Apply (A), Analyse (An), Evaluate I, Create (C)

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	2	2	3	3	2	1
CO 2	3	2	2	3	3	2	1
CO 3	3	3	3	3	3	2	0
CO 4	3	3	3	3	3	2	0
CO 5	3	2	3	3	3	2	1

Correlation level 0-None, 1-Slight, 2-Medium, 3-High

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS

1	**Moment of inertia**		**12**
	1	Equation of motion of a rotating rigid body- angular momentum and moment of inertia-radius of gyration	3
	2	Theorems on moment of inertia-theorem of parallel axes, theorem of perpendicular axes	2
	3	Calculation of moment of inertia of different bodies- thin uniform rod, rectangular lamina, circular ring, circular disc, annular disc, solid cylinder, hollow cylinder, solid sphere, a spherical shell	6
		Sections 8.1, 8.5, 8.6 of Book 1	
2	**Elasticity**		**14**
	1	Elasticity, Stress and Strain, Hooke's law, Behaviour a wire under increasing load, Youngs modulus, Bulk modulus, Isothermal and adiabatic elasticity of a gas, Modulus of rigidity,Poisson's ratio.	4
	2	Relation connecting various elastic constants Y, K,η, σ (Derivation not required), Limiting values of σ . Workdone per unit volume in a deforming body.	4
	3	Angle of twist and angle of shear, Twisting couple on a cylindrical rod or wire, work done in twisting a wire or rod, Determination of modulus of rigidity dynamically- torsional pendulum	4
		Bending of beams, bending moment, Beam supported at its ends and loaded in the middle (Non-uniform bending)	2
		Sections 12.1- 12.10, 12.12-12.17, 12.18 (3a), 12.20, 12.23 Book 1	
3	**Fluid Mechanics**		**10**
	1	Gases, Liquids and Density	2
	2	Pressure in a fluid-Pressure depth and Pascal's law, Absolute pressure and gas pressure, Pressure gauges	4
	3	Buoyancy, Surface tension, Fluid flow-The continuity equation, Bernoulli's equation, Viscosity and turbulence	4
		Sections 12.1 – 12.6 Book 2	
4	**Kinetic Theory of gases**		**10**
	1	Equations of state- ideal gas equation-Van der Waal's equation	4

	2	Molecular properties of matter-molecules and intermolecular forces-moles and Avogadro's number	2
	3	Kinetic - molecular model of an ideal gas-collisions and gas pressure-pressure and molecular kinetic energies-molecular speeds-collision between molecules	4
		Sections 18.1-18.3 Book 2	
5	**Practical Module**		**30**
	Directions: At least 5 *experiments from the following and 2 experiments/activities designed by course faculty.*		
	1. Young's modulus of the material of bar -Uniform Bending using optic lever 2. Young's modulus of the material of bar-Non-uniform bending using pin & microscope 3. Rigidity modulus of a material – Static torsion 4. Compound pendulum- To find radius of gyration 5. Flywheel- Moment of inertia 6. Torsion pendulum- Moment of inertia of a disc and rigidity modulus (using two identical masses) 7. Surface Tension by capillary rise method 8. Coefficient of viscosity –Poiseuille's formula 9. Simulation experiments using expEYES-SEELAB/Virtual lab/ PhET simulations		

Essential Readings:

1. Mechanics - Oscillations and Properties of Matter, J C Upadhyaya, Ram Prasad Publications, 2017.
2. University Physics with Modern Physics – Hugh D Young & Roger A Freedman-14th edition, 2016.

Suggested Readings:

1. A Treatise on General Properties of Matter – Chatterjee & Sengupta, New Central Book Agency (P) Limited, 2011.
2. Properties of matter, Brijlal and N Subramanyam, Eurasia Publishing House Limited, 1993.

Assessment Rubrics:

<table>
<tr><th colspan="3">Evaluation Type</th><th>Marks</th><th colspan="3">Evaluation Type</th><th>Marks</th><th>Total</th></tr>
<tr><td colspan="3">Lecture</td><td>75</td><td colspan="3">Practical</td><td>25</td><td rowspan="7">100</td></tr>
<tr><td>a)</td><td colspan="2">ESE</td><td>50</td><td>a)</td><td colspan="2">ESE</td><td>15</td></tr>
<tr><td>b)</td><td colspan="2">CCA</td><td>25</td><td>b)</td><td colspan="2">CCA</td><td>10</td></tr>
<tr><td></td><td>i</td><td>*Test Paper</td><td>10</td><td></td><td>i</td><td>Punctuality</td><td>3</td></tr>
<tr><td></td><td>ii</td><td>**Assignment/ Book-Article review</td><td>10</td><td></td><td>ii</td><td>Skill</td><td>4</td></tr>
<tr><td></td><td>iii</td><td>Seminar/ Viva-Voce</td><td>5</td><td></td><td>iii</td><td>Record</td><td>3</td></tr>
</table>

* Best out of two test papers

** or any other activities quiz, open book exam, group activity

KU2DSCPHY121:Physics of Atoms, Molecules and Nuclei

Semester	Course Type	Course Level	Course Code	Credit	Total Hours
II	DSC	100	KU2DSCPHY121	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture+ Tutorial	Practical	CE	ESE	Total	
3	2	35	65	100	2

Course Description:

This course will provide the student an understanding of atom models, wave properties of particles and their applications. The student will learn to apply Schrodinger equation for simple problems. An elementary understanding of bonding in solids and molecular spectroscopy is included.

Course Prerequisite: Higher secondary level Physics Chemistry and Mathematics

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the structure of atom and different atom models	U
2	Understand wave properties of particles	U
3	Understand quantum physics and Apply Schrodinger equation for simple one-dimensional problems.	U & A
4	Understand Bonding in solids and Analyse spectral properties of diatomic molecules	U & An

***Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)**

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	2	1	3	2	2	0
CO 2	3	2	0	3	2	2	1
CO 3	3	3	1	3	2	2	1
CO 4	3	2	1	3	2	2	1

***Correlation level 0-None, 1-Slight, 2-Medium, 3-High**

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**Particle properties of waves and wave properties of particle**		**12**
		Blackbody spectrum- Wein's displacement law, Planck's hypothesis, Planck's radiation formula (Derivation not required)	**4**
		Photoelectric Effect - experimental results - Quantum theory-Einstein photoelectric equation	**4**
		De Broglie hypothesis, De Broglie wavelength, Experimental study of matter waves-Davisson and Germer Experiment, Heisenberg Uncertainty principle- statement and expression	**4**
		Sections 8.1, 8.4, 8.5, chapter 9, 11.1,11.3	
2	**Structure of the atom**		**9**
	1	Introduction, Rutherford's experiments on scattering of α particles Rutherford atom model- Drawbacks of Rutherford atom model.	4

	2	Bohr atom model – Basics postulates and explanations, Bohr formula, Calculation of total energy, Bohr's interpretation of the hydrogen spectrum, Spectral series of hydrogen atoms, drawbacks of Bohr atom model.	5
		Sections 6.1, 6.2, 6.4	
3	**Lasers, Molecular spectra and Raman effect**		**12**
	1	Induced absorption, spontaneous emission, stimulated emission, Ruby laser, He- Ne laser, Semiconductor laser, properties of laser beam	4
	2	Origin, nature of molecular spectra, different modes of molecular excitations, factors affecting linewidth, intensity of molecular spectra.	4
	3	Rayleigh scattering, Raman effect-discovery, experimental study, Quantum theory, Applications	4
		Sections 19.1- 19.5, 23.1-23.5, 19.10-19.14	
4	**Introduction To Nucleus & Nuclear Structure**		**12**
	1	Introduction, Classification of Nuclei, General properties of Nucleus	3
	2	Binding Energy, Nuclear Stability,	3
	3	Discovery of radioactivity, natural radioactivity, Alpha, beta gamma rays, Law of Radioactive Disintegration, mean life, Radiometric Dating,	3
	4	Nuclear Fission, Energy released in fission, Nuclear Reactor, Nuclear Fusion, sources of stellar energy	**3**
		Book 1- Sec 27.1-27.5, 31.1-31.3, 31.30, 31.31,31.35, 35.2, 35.3, 35.6. 35.7. 35.8	
5	**Practical Module**		**30**
	Directions: **At least 4** experiments from the following + 2 Activities (can be selected from the list or can be designed by course faculty.)		
	1. Liquid lens - Refractive index of a liquid and material of the lens using another liquid of known refractive index. 2. Compound pendulum radius of gyration 3. Spectrometer – refractive index of a prism 4. CF Bridge -Resistance and resistivity		

	5. Potentiometer calibration of low range voltmeter 6. Deflection Magnetometer –Tan A and Tan B 7. Construction of Logic gates – AND , OR verification of truth table 8. Simulations-Structural elucidation of simple molecules by analysing IR spectrum, Spectral analysis of UV-Vis spectrum	

Essential Readings:

1. Modern Physics by R Murugeshan, Kiruthiga Sivaprasath, S Chand Publishing, 17th Edition, .

Suggested Readings:

1. Concepts of Modern Physics by Arthur Beiser, 6th Edn, Mc Grew Hill, 2020.
2. Modern Physics by Kenneth S Krane, 4th Edn, Wiley India, 2020.
3. Fundamentals of molecular spectroscopy by Banwell, Elaine M McCash, Mc Grew Hill, 1994.
4. University Physics with Modern Physics - Young and Freedman-14th Edn, 2016.

Assessment Rubrics:

<table>
<tr><th colspan="3">Evaluation Type</th><th>Marks</th><th colspan="3">Evaluation Type</th><th>Marks</th><th>Total</th></tr>
<tr><td colspan="3">Lecture</td><td>75</td><td colspan="3">Practical</td><td>25</td><td rowspan="6">100</td></tr>
<tr><td>a)</td><td colspan="2">ESE</td><td>50</td><td>a)</td><td colspan="2">ESE</td><td>15</td></tr>
<tr><td>b)</td><td colspan="2">CCA</td><td>25</td><td>b)</td><td colspan="2">CCA</td><td>10</td></tr>
<tr><td></td><td>i</td><td>*Test Paper</td><td>10</td><td></td><td>i</td><td>Punctuality</td><td>3</td></tr>
<tr><td></td><td>ii</td><td>**Assignment/ Book-Article review</td><td>10</td><td></td><td>ii</td><td>Skill</td><td>4</td></tr>
<tr><td></td><td>iii</td><td>Seminar/ Viva-Voce</td><td>5</td><td></td><td>iii</td><td>Record</td><td>3</td></tr>
</table>

*Best out of two test papers

** or any other activities like quiz, open book exam, group activity

KU2DSCPHY122: Mathematics for Physical Systems

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
2	DSC	100	KU2DSCPHY122	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture+ Tutorial	Practical	CE	ESE	Total	
3	2	35	65	100	2

Course Description:

This course provides a comprehensive exploration of calculus, from basic derivatives to integral calculus and the fundamental theorems. It gives an understanding of curvilinear coordinates, divergence, and curl in various coordinate systems, emphasizing applications in electromagnetism. Furthermore, it covers ordinary differential equations, including first and second-order equations, with practical examples from physics and engineering. Additionally, students study complex numbers and functions, understanding their geometric interpretations and applications in AC circuit analysis.

Course Prerequisite: Higher secondary level Physics

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand and apply the principles of differential calculus and integral calculus and the concepts of ordinary differential equations	*U*

2	Apply the fundamental theorem of calculus to gradient divergence and curl and Gauss's law to determine electric field due to charge distributions	*A*
3	Analyse AC circuits using complex reactance analyse and solve differential equations	*An*
4	Apply differential equations to model physical systems	*A*
5	Understand the nature of complex numbers and functions	*U*

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	3	1	3	3	2	0
CO 2	3	3	1	3	3	2	1
CO 3	3	3	1	3	3	2	0
CO 4	3	3	1	3	3	2	1
CO 5	3	3	1	3	2	2	1

Correlation level 0-None, 1-Slight, 2-Medium, 3-High

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**Vector Calculus**		**11**
	1	Differential Calculus - Ordinary derivatives, Gradient, The Del operator, The Divergence, The Curl	3
	2	Integral Calculus- Line , Surface and Volume Integrals	4
	3	The fundamental theorem of Calculus- The fundamental theorem for gradients, The fundamental theorem for divergence , The fundamental theorem of curl	4
Section 1.2.1 to 1.2.5, 1.3,1 to 1.3.5 of Book1			
2	**Curvilinear Coordinates**		**11**
	1	Spherical Coordinates, cylindrical coordinates	4
	2	Divergence and Curl of electrostatic fields-Field lines, flux and Gauss's law divergence and Curl of magnetic field	4
	3	Gauss's law, Applications of Gauss's law-field due to uniformly charged solid sphere and solid cylinder	3
Section 1.4.1 ,1.4.2, 2 ,2.2.1 , 2.2.4 , 5.3.1, 5.3.2 of Book 1			
3	**Ordinary Differential Equations**		**12**
	1	First Order ODE- Basic Concepts-Concept of solution -initial value problem- Radioactive decay, Separable ODE- initial value problem-Radiocarbon dating-Newton's law of cooling, Linear first order ODE-homogeneous ODE-Non-Homogeneous ODE -Initial value problem-Electric circuit	5
	2	Second order Linear ODE-Homogeneous Linear ODE-Initial value problem-general solution - Homogeneous ODE with constant coefficients-case I,II,III	4
	3	Free Oscillations of Mass Spring system- ODE of undamped system	3
Section 1.1,1.3,1.4, 1.5,2.1,2.2,2,4 of Book 2			

4	**Complex Numbers and Functions**		**11**
	1	Complex number and geometrical representation-addition, multiplication, subtraction, division, complex plane, complex conjugate numbers	5
	2	Polar Form of Complex Numbers, Powers and roots-multiplication and division in polar form, Exponential functions, Trigonometric and Hyperbolic Functions	6
Section 13.1,13.2,13.4-13.6 of Book 2			
5	**Practical Module**		**30**
	*Directions:**At least 5** experiments from the following + 2 Activities (can be selected from the list or designed by course faculty*.)		
	1. Air Wedge-Diameter of a thin wire- Error Analysis 2. Liquid lens - Refractive index of a liquid and material of the lens using another liquid of known refractive index. 3. Spectrometer – Refractive index of the material of a prism 4. Carey Fosters Bridge- resistance & resistivity 5. Potentiometer calibration of low range voltmeter 6. Deflection Magnetometer –Tan A and Tan B 7. Determine radius of gyration using compound pendulum 8. Logic gates OR, AND using diodes 9. RC and RL transients - determination of capacitance and inductance. https://expeyes.in/experiments/electrical/rctransient.html https://expeyes.in/experiments/electrical/rltransient.html 10. Series LCR circuit using Virtual labs https://asnm-iitkgp.vlabs.ac.in/exp/rlc-circuit-analysis/simulation. Or Series LCR circuit using Amritha V lab 11. . Electric field simulation https://interactives.ck12.org/simulations/physics.html		

Essential Readings:

1. Introduction to Electrodynamics(4^{th} Edn) by David J Griffiths, 2015.
2. Advance Engineering Mathematics(10^{th} Edn) by Erwin Kreyzig, 2011.

Suggested Readings:

1. Mathematical Physics (6th Edn) by Sathyaprakash, S Chand & Sons, 2014.
2. Mathematical Physics (8th Edn) by H K Daas, Rama Verma, S Chand & Sons, 2019.

Assessment Rubrics:

Evaluation Type			**Marks**	**Evaluation Type**			**Marks**	**Total**
Lecture			**75**	**Practical**			**25**	**100**
a)	**ESE**		**50**	a)	**ESE**		**15**	
b)	**CCA**		**25**	b)	**CCA**		**10**	
	i	*Test Paper	10		i	Punctuality	3	
	ii	**Assignment/ Book-Article review	10		ii	Skill	4	
	iii	Seminar/ Viva-Voce	5		iii	Record	3	

*Best out of two test papers

** or any other activities like quiz, open book exam, group activity

KU2DSCPHY123: Fundamentals of Optics

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
II	DSC	100	KU2DSCPHY123	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture+ Tutorial	Practical	CE	ESE	Total	
3	2	35	65	100	2

Course Description:

This course provides a comprehensive exploration of optics, covering topics such as the nature and propagation of light, geometric optics, interference, and diffraction phenomena. Students will learn about the laws of reflection and refraction, interference patterns, diffraction from single and multiple slits, and the principles behind optical instruments like lenses and spectrometers.

Course Prerequisite: Higher secondary level Physics

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	To understand what light rays are, and how they are related to wave fronts, the laws that govern the properties of light. Analyse Huygen's principle.	*U, An*
2	To identify formation of image by plane mirror and a curved interface between two transparent materials. Analyse the causes of various defects in human vision, and correction measures.	*U, An*

3	To understand interference and interference patterns.	*U, A*
4	To analyse diffraction at an edge or aperture usage of diffraction gratings for precise measurements of wavelength.	*An, A*

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	2	1	3	3	2	1
CO 2	3	2	1	2	3	2	0
CO 3	3	2	0	3	3	2	0
CO 4	3	2	1	3	3	2	1

Correlation level 0-None, 1-Slight, 2-Medium, 3-High

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**The Nature and Propagation of Light**		**12**
	1	The nature of Light, Two properties of light, Waves, Wavefronts and rays	2
	2	Reflection- The laws of reflection and Refraction, refraction- Index of Refraction and wave aspects of light, Total internal reflection- Application, Dispersion- Rainbows, Polarization- Polarization by reflection, Circular and elliptical polarization, Photo elasticity	4

	3	Scattering of Light	3
	4	Huygen's Principle	3
		Book 1- Sec 33.1-33.7	
2	**Geometric Optics**		**14**
	1	Reflection and Refraction at a plane surface- Image formation by a plane mirror, Sign rules, Image of an extended object: Plane mirror	4
	2	Reflection at a spherical surface-Image of a point object: Spherical Mirror, Focal point and Focal length, Image of an extended object: Spherical Mirror	4
	3	Refraction at a spherical surface- Thin Lenses- Properties , Converging and Diverging Lenses, The Lens Maker's Equation	3
	4	The Eye- Defects of Vision, The Magnifier	3
	5	**Book 1- Sec 34.1-34.4, 34.6, 34.7**	
3	**Interference**		**10**
	1	Interference and Coherent Sources: Interference in Two or Three Dimensions. Constructive and Destructive Interference	3
	2	Two Source Interference of light- Constructive and Destructive two slit Interference, Interference in thin films -Thin Film Interference and phase shifts during reflection, thin and thick films	4
	3	Newton's Rings- Non reflective and reflective coatings,	3
		Book 1- Sec 35.1 – 35.2, 35.4	
4	**Diffraction**		**9**
	1	Fresnel and Fraunhofer Diffraction- Diffraction and Huygen's Principle,	3
	2	Diffraction from a single slit, Intensity maxima in single slit pattern, Width of single slit pattern	3
	3	Multiple slits, The Diffraction Grating	3
		Book 1 -Sec 36.1- 36.5	
5	**Practical Module**		**30**
	1. Spectrometer- Refractive Index of the prism		

	2. Carey Fosters Bridge- resistance & resistivity 3. Potentiometer calibration of low range voltmeter 4. Deflection Magnetometer –Tan A and Tan B 5. Laser- Determination of slit width 6. Laser- Diameter of thin wire 7. Liquid lens -Refractive index of a liquid and material of the lens using another liquid of known refractive index. 8. Air Wedge- Diameter of Thin wire 9. Logic gates OR, AND using diodes 10. Simulations lasers, holography- Introduction	

Essential Readings:

1. University Physics with Modern Physics- Hugh D Young and Roger A Freedman-14th Edn. ,2016.

Suggested Readings:

1. Optics and Spectroscopy- R. Murugeshan and Kiruthiga Sivaprasath, S Chand Publishing, 2010.
2. A Textbook of Optics- R.Subhrahmanyam, Brijlal and M. N. Avandhanulu 25th Edn, 2020.

Assessment Rubrics:

Evaluation Type			**Marks**	**Evaluation Type**			**Marks**	**Total**
Lecture			**75**	**Practical**			**25**	**100**
a)	**ESE**		**50**	a)	**ESE**		**15**	
b)	**CCA**		**25**	b)	**CCA**		**10**	
	i	*Test Paper	10		i	Punctuality	3	
	ii	**Assignment/ Book-Article review	10		ii	Skill	4	
	iii	Seminar/ Viva-Voce	5		iii	Record	3	

*Best out of two test papers

** or any other activities like quiz, open book exam, group activity

KU2DSCPHY124 :Heat and Thermodynamics

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
2	DSC	100	KU2DSCPHY124	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture+ Tutorial	Practical	CE	ESE	Total	
3	2	35	65	100	2

Course Description:

This course explores temperature, heat, and thermal equilibrium, introducing the foundational concepts of thermodynamics through the zeroth and first laws. Students delve into thermal expansion, calorimetry, and heat transfer mechanisms. They then progress to understanding thermodynamic systems, work, internal energy, and processes, culminating in the second law and entropy, with a focus on applications like heat engines and refrigerators. Throughout, emphasis is placed on the fundamental principles governing energy flow and efficiency in various systems.

Course Prerequisite: Higher secondary level Physics

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the fundamental principles of heat transfer	U
2	Apply the laws of thermodynamics to solve problems related to heat transfer	A

3	Demonstrate an understanding of heat engines refrigerators and their applications in everyday life	A
4	Evaluate the efficiency of different heat transfer processes and systems	E
5	Develop critical thinking and problem-solving skills in the context of heat and thermal physics	An

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	2	1	3	3	2	1
CO 2	2	2	1	3	3	2	0
CO 3	3	3	0	3	3	2	1
CO 4	2	2	1	2	3	2	1
CO 5	3	2	0	2	2	3	1

****Correlation level 0-None, 1-Slight, 2-Medium, 3-High***

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**Temperature and heat**		**10**
	1	Temperature and thermal equilibrium	2
	2	Zeroth law of thermodynamics	2

	3	Thermometers and temperature scales, Gas Thermometers and Kelvin scale, Kelvin scale and absolute temperature,	2
	4	Thermal Expansion, Quantity of heat, Calorimetry and Phase changes, Mechanisms of heat transfer	4
		Sections 17.1-17.3, 17.4, 17.5-17.7- Book 1	
2	**Thermodynamics and first law of Thermodynamics**		**14**
	1	Thermodynamic systems, Work done during volume changes, Paths between thermodynamic states	4
	2	Internal energy and First law of thermodynamics,	3
	3	Kinds of thermodynamic processes,	3
	4	Internal energies of ideal gas, Heat capacities of ideal gases, adiabatic process in ideal gases	4
	5	**Sections 19.1, 19.2, 19.3, 19.4, 19.6-19.8 Book1**	
3	**Second law of Thermodynamics**		**12**
	1	Directions of Thermodynamic processes	2
	2	Heat engines, hot and cold reservoirs, Energy flow diagram and efficiency, Refrigerators	4
	3	The second law of thermodynamics, Carnot cycle	3
	4	Carnot refrigerator, Carnot cycle and second law	3
		Sections 20.1, 20.2, 20.4, 20.5, 20.6 Book 1	
4	**Entropy**		**9**
	1	Entropy and disorder	2
	2	Entropy in reversible processes, irreversible processes, cyclic processes	3
	3	Entropy and second law	2
	4	Microscopic Interpretation of entropy	2
Sections 20.7, 20.8, Book 1			
5	**Practical Module**		**30**
	*Directions: **At least 5** experiments from the following + 2 Activities (can be selected from the list or teacher can design.*		
	1. Potentiometer- calibration of low range voltmeter		

	2. Spectrometer –Refractive index of a prism 3. Liquid lens - Refractive index of a liquid and material of the lens using another liquid of known refractive index. 4. Newton’s law of cooling- Specific heat of a liquid 5. Air Wedge-Diameter of a thin wire 6. CF bridge-resistance and resistivity 7. Deflection Magnetometer –Tan A and Tan B 8. Logic gates OR, AND using diodes 9. Simulations based on Heat and Thermodynamics	

Essential Readings:

1. University Physics with Modern Physics- Hugh D Young and Roger A Freedman-14th Edn. ,2016.

Suggested Readings:

1. Heat and Thermodynamics- Brijlal, N. Subrahmanyam and P S Hemne, S Chand Publications, 2018.
2. Heat and Thermodynamics- Mark Zemansky and Richard Dittman, 8th Edn, McGraw Hill Education, 2017.

Assessment Rubrics:

<table>
<tr><th colspan="3">Evaluation Type</th><th>Marks</th><th colspan="3">Evaluation Type</th><th>Marks</th><th>Total</th></tr>
<tr><td colspan="3">Lecture</td><td>75</td><td colspan="3">Practical</td><td>25</td><td rowspan="6">100</td></tr>
<tr><td>a)</td><td colspan="2">ESE</td><td>50</td><td>a)</td><td colspan="2">ESE</td><td>15</td></tr>
<tr><td>b)</td><td colspan="2">CCA</td><td>25</td><td>b)</td><td colspan="2">CCA</td><td>10</td></tr>
<tr><td></td><td>i</td><td>*Test Paper</td><td>10</td><td></td><td>i</td><td>Punctuality</td><td>3</td></tr>
<tr><td></td><td>ii</td><td>**Assignment/ Book-Article review</td><td>10</td><td></td><td>ii</td><td>Skill</td><td>4</td></tr>
<tr><td></td><td>iii</td><td>Seminar/ Viva-Voce</td><td>5</td><td></td><td>iii</td><td>Record</td><td>3</td></tr>
</table>

*Best out of two test papers

** or any other activities like quiz, open book exam, group activity

KU2DSCPHY125: Digital Electronics

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
II	DSC	100	KU2DSCPHY125	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture+ Tutorial	Practical	CE	ESE	Total	
3	2	35	65	100	2

Course Description:

This course introduces the principles of digital electronics, covering binary systems, logic gates, and Boolean algebra. Students will learn about combinational and sequential circuits, including adders. The course emphasizes the design and analysis of digital circuits using truth tables and Karnaugh maps. Practical applications and hands-on lab exercises reinforce theoretical concepts.

Course Prerequisite: Higher secondary level Physics

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the different number systems	*U*
2	Analyse different logic gates and create combinational circuits	*An*
3	Analyse Boolean expression and apply in circuits	*An*
4	Apply combinational logic	*A*

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	3	1	2	2	3	1
CO 2	3	2	0	3	3	3	1
CO 3	3	2	1	3	3	3	1
CO 4	3	2	1	3	3	3	1

Correlation level 0-None, 1-Slight, 2-Medium, 3-High

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**Number Systems**		**10**
	1	Decimal numbers, Binary numbers	2
	2	Decimal to Binary Conversion	2
	3	Binary Arithmetic, Complements of Binary Numbers, Signed Numbers, Arithmetic Operations with signed Numbers,	3
	4	Hexadecimal Numbers, Octal Numbers, Binary Coded Decimal (BCD), Digital Codes	3
		(Book 1, Sections 2.1 to 2.11)	
2	**Logic Gates**		**10**
	1	Analog and Digital Quantities,	2
	2	Binary Digits,	2
	3	Logic Levels and Digital wave forms	3

	4	Basic Logic Functions, Inverter(NOT gate), AND Gates, OR Gate, NAND gate, NOR Gate, Exclusive – OR and Exclusive – NOR Gates.	3
		(Book 1: Sections 1.1 – 1.3, 3.1 – 3.6)	
3	**Boolean Algebra and Logic Simplification**		**13**
	1	Boolean Operation and Expression, Laws and Rules of Boolean Algebra	3
	2	DeMorgan's Theorem, Boolean Analysis of Logic Circuits	3
	3	Logic Simplification using Boolean Algebra, Standard Forms of Boolean Expressions, Boolean Expressions and Truth Tables,	3
	4	Karnaugh Map and Karnaugh Map SOP Minimization	4
		(Book 1: Sections 4.1 – 4.9)	
4	**Combinational Logic Analysis and Function of Combinational Logic**		**12**
	1	Basic Combinational Logic Circuits, Implementing Combinational Logic	4
	2	Universal Properties of NAND and NOR Gates, Combinational Logic using NAND and NOR Gates,	4
	3	Half and Full Adders, Parallel Binary Adders, Comparator	4
		(Book 1: Sections 5.1 – 5.4, 6.1 – 6.2, 6.4)	
5	**Practical Module**		**30**
	Directions: ***At least 5*** *experiments from the following + 2 Activities (can be selected from the list or can be designed by the course faculty.)*		
	1. Realization of AND, OR, NOT logic gates using diodes and verify with truth table 2. Study of Digital ICs and IC trainer kit 3. Liquid lens - Refractive index of a liquid and material of the lens using another liquid of known refractive index. 4. Spectrometer – Refractive index of the material of a prism 5. Carey Fosters Bridge- resistance & resistivity 6. Potentiometer calibration of low range voltmeter 7. Deflection Magnetometer –Tan A and Tan B		

Essential Readings:

1. Digital Fundamentals , 11th Edition, Thomas L Floyd (Pearson), 2017.

Suggested Readings:

1. Digital Principles and Applications - D P Leach and A P Malvino (TMH), 8th Edn, 2014.
2. Fundamentals of Digital Ciruits - A Anandakumar (PHI), 4th Edn, 2016.
3. Principle of Electronics, V K Metha and Rohith Mehtha, 11th Edn, S Chand & Company, 2019.
4. Digital Electronics circuits and Systems – V K Puri, McGraw Hill, 2017.

Assessment Rubrics:

<table>
<tr><th colspan="3">Evaluation Type</th><th>Marks</th><th colspan="3">Evaluation Type</th><th>Marks</th><th>Total</th></tr>
<tr><td colspan="3">Lecture</td><td>75</td><td colspan="3">Practical</td><td>25</td><td rowspan="6">100</td></tr>
<tr><td>a)</td><td colspan="2">ESE</td><td>50</td><td>a)</td><td colspan="2">ESE</td><td>15</td></tr>
<tr><td>b)</td><td colspan="2">CCA</td><td>25</td><td>b)</td><td colspan="2">CCA</td><td>10</td></tr>
<tr><td></td><td>i</td><td>*Test Paper</td><td>10</td><td></td><td>i</td><td>Punctuality</td><td>3</td></tr>
<tr><td></td><td>ii</td><td>**Assignment/ Book-Article review</td><td>10</td><td></td><td>ii</td><td>Skill</td><td>4</td></tr>
<tr><td></td><td>iii</td><td>Seminar/ Viva-Voce</td><td>5</td><td></td><td>iii</td><td>Record</td><td>3</td></tr>
</table>

*Best out of two test papers

** or any other activities like quiz, open book exam, group activity

KU2DSCPHY126: Introduction to AI tools

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
II	DSC	100	KU2DSCPHY126	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture+ Tutorial	Practical	CE	ESE	Total	
3	2	35	65	100	2

Course Description:

This course introduces the concepts and techniques of AI and ML, focusing on their practical applications in solving complex problems in physics and related areas. It covers essential topics such as supervised and unsupervised learning, neural networks, and the implementation of AI/ML algorithms.

Course Prerequisite:

- Basic programming knowledge (Python is highly recommended).
- Fundamental understanding of statistics and linear algebra.

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the fundamental concepts of AI and ML.	*U*
2	Recognize the applicability of AI/ML methods in physics.	*A*
3	Implement basic AI/ML algorithms using appropriate tools.	*C*

4	Analyse and interpret results obtained from AI/ML models.	*An*
5	Critically assess the limitations and ethical considerations of AI/ML.	*E*

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	2	1	3	3	2	3
CO 2	3	2	1	3	3	2	3
CO 3	2	3	2	3	3	2	2
CO 4	3	2	1	3	3	2	3
CO 5	2	2	1	2	2	2	2

Correlation level 0-None, 1-Slight, 2-Medium, 3-High

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**Introduction to AI, Machine Learning Data Handling and Pre-processing**		**13**
	1	Historical background and evolution of AI, Overview of AI and ML in the modern context	3
	2	Applications of AI/ML in various fields, with an emphasis on physics.	3
	3	Introduction to data structures relevant to AI/ML.	3
	4	Techniques for data cleaning, normalisation, and transformation, Visualisation of multidimensional data.	4

		Book 1 – Chapters 3,4,5 Book 2-Chapter 1	
2	**Supervised Learning and Unsupervised Learning**		**12**
	1	Basic concepts of supervised learning, Linear regression, logistic regression.	3
	2	Decision trees and support vector machines	3
	3	Basic concepts of unsupervised learning. Clustering algorithms (k-means, hierarchical clustering).	3
	4	Dimensionality reduction techniques (PCA, t-SNE).	3
		Book 1- Chapters 2,3,5,11	
3	**Neural Networks and Deep Learning**		**8**
	1	Introduction to neural networks.	3
	2	Fundamentals of deep learning.	2
		Applications of deep learning in image and speech recognition.	3
		Book2- Chapters 6,12	
4	**Ethical Considerations and Future of AI/ML and Special Topics in Physics**		**12**
	1	Discussion on the ethical implications of AI.	3
	2	The future landscape of AI/ML in research and industry.	3
	3	Use of AI/ML in solving physics problems (e.g., pattern recognition in particle physics, prediction models in astrophysics).	3
	4	Case studies highlighting the integration of AI/ML with physics research.	3
		Book 2- Chapter 19, Problems in Book 1 and Book 2	
5	**Practical Module**		**30**
	*Directions: **At least 5** experiments from the following + 2 Activities (can be selected from the list or can be designed by the course faculty.)*		
	1. Potentiometer- calibration of low range voltmeter 2. Liquid lens - Refractive index of a liquid and material of the lens using another liquid of known refractive index. 3. Spectrometer –Refractive index of a prism 4. CF bridge-resistance and resistivity		

	5. Deflection Magnetometer –Tan A and Tan B 6. Logic gates OR, AND using diodes 7. Students undertake a small project or case study where they apply AI/ML concepts to a physics-related problem. 8. Presentation of project work and discussions. 9. Guest lectures by experts in AI/ML and physics. 10. Access to online platforms for AI/ML practice and coding. 11. Encouragement of collaborative learning and peer review.	

Essential Readings:

1. Python Machine Learning by Sebastian Raschka and Vahid Mirjalili, Packt Publishing, 3rd Edn,. 2019.
2. Deep Learning by Ian Goodfellow, Yoshua Bengio, and Aaron Courville, 2017.
3. Online resources, including tutorials and datasets for practical exercises.

Suggested Readings:

1. Storytelling with Data: A Data Visualization Guide for Business Professionals by Cole Nussbaumer Knaflic, 2015.
2. Cambridge IGCSE and O Level Computer Science by David Watson & Helen Williams, 2nd Edn., 2021.

Assessment Rubrics:

<table>
<tr><th colspan="3">Evaluation Type</th><th>Marks</th><th colspan="3">Evaluation Type</th><th>Marks</th><th>Total</th></tr>
<tr><td colspan="3">Lecture</td><td>75</td><td colspan="3">Practical</td><td>25</td><td rowspan="6">100</td></tr>
<tr><td>a)</td><td colspan="2">ESE</td><td>50</td><td>a)</td><td colspan="2">ESE</td><td>15</td></tr>
<tr><td>b)</td><td colspan="2">CCA</td><td>25</td><td>b)</td><td colspan="2">CCA</td><td>10</td></tr>
<tr><td></td><td>i</td><td>*Test Paper</td><td>10</td><td></td><td>i</td><td>Punctuality</td><td>3</td></tr>
<tr><td></td><td>ii</td><td>**Assignment/ Book-Article review</td><td>10</td><td></td><td>ii</td><td>Skill</td><td>4</td></tr>
<tr><td></td><td>iii</td><td>Seminar/ Viva-Voce</td><td>5</td><td></td><td>iii</td><td>Record</td><td>3</td></tr>
</table>

*Best out of two test papers

** or any other activities like quiz, open book exam, group activity

KU2DSCPHY127: Instrumentation Techniques in Biophysics

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
II	DSC	100	KU2DSCPHY127	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture+ Tutorial	Practical	CE	ESE	Total	
3	2	35	65	100	2

Course Description:

This course provides an in-depth overview of key spectroscopic and microscopic techniques used in biophysical research. It begins with the principles and applications of visible and infrared absorption spectroscopy, including instrumentation, spectral analysis, and molecular interactions. Raman scattering spectroscopy is then explored, emphasizing classical and enhanced techniques for probing molecular vibrations and structures. The microscopy module covers the fundamentals of optical and atomic force microscopy, highlighting resolution limits, contrast mechanisms, and imaging modes for biological samples. Finally, electron microscopy is introduced, detailing image formation, electron optics, specimen preparation, and advanced imaging techniques for high-resolution structural analysis.

Course Prerequisite: Higher secondary level Physics

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Students will be able to explain the theoretical principles behind UV-visible and IR absorption spectroscopy and apply them to analyse biomolecular structures and interactions.	*R, U, A*

2	Students will understand the principles of Raman scattering and its advanced techniques (RRS, SERS), and will be able to interpret Raman spectra in the context of biological systems.	*R, U*
3	Students will demonstrate knowledge of light microscopy and atomic force microscopy, including their limitations, imaging modes, and applications in visualizing biological specimens.	*R, U, An*
4	Students will be able to describe the working principles of transmission and scanning electron microscopes and utilize this knowledge to evaluate ultrastructural features of biological samples.	*R, U, An*

***Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)**

Mapping of Course Outcomes to PSOs

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**
CO 1	2	1	3	3	2	3	3
CO 2	2	1	2	3	2	3	3
CO 3	1	1	2	3	1	2	3
CO 4	2	1	2	3	1	2	3

***Correlation level 0-None, 1-Slight, 2-Medium, 3-High**

COURSE CONTENTS

Contents for Classroom Transaction:

M O D U L E	U N I T	DESCRIPTION	HOURS
1	**Part A: Spectroscopy: Visible and IR Absorption Spectroscopy**		**10**
	1	Brief historical review and biological applications, Brief theoretical outline, The extinction coefficient and absorbance	**3**
	2	The UV-visible spectral range, UV-visible spectrophotometers and measurement strategies	**4**
	3	IR absorption spectroscopy, IR spectrometers, IR-active and IR-inactive modes.	**3**
	Sections E1.1, E1.2, E1.3, E1.3.1, E1.4, E1.4.1, E1.4.3 of Book 1		
2	**Part A: Spectroscopy: Raman Scattering Spectroscopy**		**9**
	1	Historical review and introduction to biological problems, Classical Raman spectroscopy, Raman spectra	**2**
	2	Frequency, intensity and polarisation	**3**
	3	Raman spectrometers and Raman microscopes	**2**
	4	Resonance Raman spectroscopy (RRS), Surface enhanced Raman spectroscopy(SERS).	**2**
	Sections E3.1, E3.2, E3.2.1, E3.2.2, E3.2.3, E3.3, E3.4 of Book 1		
3	**Part B: Microscopy: Optical Microscopy and Atomic Force Microscopy**		**12**
	1	Historical review, Light microscope, Light microscopy inside the classical limit	**2**
	2	The standard light microscope, One-lens microscope, Compound microscope, Diffraction limit of resolution, The problem of contrast	**4**
	3	Atomic force microscopy, Historical review, Introduction to biological problems	**2**
	4	General principles, The tip, a key element of an SFM, Imaging modes, Imaging of biological structures.	**4**

	Sections F1.1, F1.1.1, F1.2, F1.2.1, F1.2.2, F2.1, F2.2, F2.3, F2.3.1, F2.3.2, F2.4 of Book 1		
4	**Part B: Microscopy: Electron Microscopy**		**14**
	1	Historical review, Introduction to biological problems, The electron microscope image, Applications of EM, Principles of electron diffraction and imaging, Properties of electrons, Electromagnetic lens, The image recorded by an electron microscope	**4**
	2	Electron beam generation, Transmission and scanning electron microscopes, Electron images, Features of an electron microscope image. Imaging phase objects, Effect of focus, Image recording system	**5**
	3	Techniques in specimen preparation: Specimen support, Negative staining, Freezing of the sample	**2**
	4	Data collection: Factors to consider during data collection, Data from single particles, Imaging crystals and helical molecules, Tomography.	**3**
	Sections H1.1, H1.2, H1.2.1, H1.2.2, H1.3, H1.3.1, H1.3.2, H1.3.3, H1.4.1, H1.4.2, H1.4.3, H1.4.4, H1.5, H1.6 of Book 1		
5	**Practical Module**		**30**
	Directions: ***At least 5*** experiments from the following + 2 Activities (can be selected from the list or can be designed by the course faculty.)		
	1. Laser- Determination of slit width. 2. Generate a basic line graph, scatter plot and bar chart for a given set of x and y values. 3. Spectrometer – refractive index of a prism. 4. Logic gates OR, AND using diodes. 5. Air Wedge- Diameter of Thin wire. 6. Reverse characteristics of Zener diode. 7. Plot and analysis some UV-visible/FTIR data of any sample using a plotting software. 8. Plot and analysis some Raman spectrometer data of any sample using a plotting software. 9. Analysis some AFM/SEM/TEM data. 10. Simulations lasers, holography- Introduction.		

Essential Readings:

2. *Methods in Molecular Biophysics: Structure, Dynamics, Function* by Igor N. Serdyuk, Nathan R. Zaccai, Joseph Zaccai (Cambridge University Press).

Suggested Readings:

1. *Advances in Imaging and Electron Physics*, Edited by Peter W Hawkes (Academic Press).
2. *Fundamentals of Light Microscopy and Electronic Imaging*, By Douglas B. Murphy (Wiley-Liss, Inc.).
3. *Springer Handbook of Nanotechnology*, Edited by Bharat Bhushan (Springer).

Assessment Rubrics:

Evaluation Type			**Marks**	**Evaluation Type**		**Marks**	Total
Lecture			**75**	**Practical**		**25**	100
(a)	**ESE**		**50**	**(a)**	**ESE**	**15**	
(b)	**CCA**		**25**	**(b)**	**CCA**	**10**	
	i	*Test Paper	10	i	Punctuality	3	
	ii	**Assignment/ Book/Article review	10	ii	Skill	4	
	iii	Seminar/ Viva-Voce	05	iii	Record	3	

*Best out of two test papers

**or any other activities like quiz, open book exam, group activity

SEMESTER III

KU3DSCPHY201: Basic Mathematical Physics

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
III	DSC	200	KU3DSCPHY201	4	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture+ Tutorial	Practical	CE	ESE	Total	
4	0	30	70	100	2

Course Description:

This course offers a comprehensive study of mathematical methods crucial in scientific disciplines. From vector algebra to linear algebra, students can study fundamental concepts like vector operations, derivatives, integrals, and differential equations, with a focus on real-world problem-solving, students gain proficiency in analysing vectors, differential equations, and matrices, preparing them for advanced studies and research in diverse fields.

Course Prerequisite: Higher secondary level Mathematics

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand vector operations and vector algebra	*U*
2	Compare differential operators in various coordinate systems	*An*
3	Understand the basic concepts of modelling and Solve first order and second order ODEs	*U,A*

4	Understand and apply fundamental concepts in linear algebra, eigenvalues and eigenvectors.	*U,A*

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	2	1	1	1	2	1
CO 2	1	3	2	1	0	0	2
CO 3	1	1	3	3	3	3	1
CO 4	2	1	1	3	3	3	1

***Correlation level 0-None, 1-Slight, 2-Medium, 3-High**

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**Vector Calculus**		**14**

	1	**Vector Algebra**: Vector Operations , Vector Algebra: Component Form, Triple Products, Position, Displacement, and Separation Vectors	4
	2	**Differential Calculus**: Ordinary Derivatives, Gradient ,The Del Operator, The Divergence, The Curl, Product Rules, Second Derivatives	5
	3	**Integral Calculus**: Line, Surface, and Volume Integrals, The fundamental theorem of Calculus, for Gradients, for Divergences, for Curls. Integration by Parts.	5
		Sections 1.1 to 1.3 Book 1	
2	**Curvilinear Coordinates**		**6**
	1	Spherical Coordinates, Cylindrical Coordinates, Their relationship to Cartesian coordinates	2
	2	Expression for differential displacement vector, differential area vectors, differential volume element	2
	3	gradient operator, divergence operator and curl operator in spherical polar and cylindrical coordinates	2
		Sections 1.4 Book 1	
3	**Modern Algebraic methods in Physics**		**12**
	1	Introduction, Matrix analysis, Matrix operations,	3
	2	Properties of arbitrary matrices, Special square matrices	3
	3	Eigenvalue Problem	3
	4	Rotations in two and three dimensions	3
		Sections 2.1-2.2.5 Book 2	
4	**Differential Equations**		**13**
	1	Ordinary differential equations-introduction, first order linear differential equations, exact differential equation	5
	2	Bernoulli differential equation	1
	3	Second order linear differential equation, Homogeneous differential equation with constant coefficient, non homogeneous differential equation with constant coefficient	5

	4	Partial differential equation- introduction	2
5		**Sections 7.1-7.4, 7.4.1, 7.4.2, 8.1 Book 2**	
	Teacher Specific Module		15
	Directions: 1. Use computational softwares or Python with NumPy to perform vector addition, subtraction, and scalar multiplication. Visualize vectors in 2D and 3D space. 2. Solve problems involving gradient, divergence, and curl using software tools. 3. Convert between Cartesian, spherical, and cylindrical coordinates using software tools. 4. Solve second-order homogeneous linear ODEs with constant coefficients using software tools. 5. Use MATLAB or Python to perform matrix operations such as addition, multiplication, and inversion		

Essential Readings:

1. Introduction to Electrodynamics – David Griffiths 4 Edn, 2015.
2. Analytic Methods in Physics, Charlie Harper, 1999.

Suggested Readings:

1. Mathematical Methods in the Physical Sciences by Mary L. Boas, 3rd Edn . 2006.
2. Mathematical Methods for Physics and Engineering, 3rdEdn.–K. F.Riley, M. P.Hobson, S. J.Bence, 2006.

Assessment Rubrics:

Evaluation Type		Marks
ESE		**70**
CCA		**30**
a)	*Test Paper	10
b)	**Assignment/ Book- Article Review	10
c)	Seminar/ Viva -Voce	10
Total		**100**

*Best out of two test papers

** or any other activities like quiz, open book exam, group activity

KU3DSCPHY202: Mechanics

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
III	DSC	202	KU3DSCPHY202	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture+ Tutorial	Practical	CE	ESE	Total	
3	2	35	65	100	2

Course Description:

This course introduces non-inertial systems and fictitious forces, such as the Coriolis force and central force motion. Students study phenomena like harmonic oscillators, waves, and relativistic effects. Emphasis is placed on understanding fundamental principles like Einstein's postulates and their consequences, preparing students to analyze complex physical systems and phenomena. Through theoretical study and practical examples, students develop a deep understanding of classical and relativistic physics concepts essential for modern scientific inquiry and technological applications.

Course Prerequisite: Higher secondary level Physics

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the concept of Galilean transformations and uniformly accelerating systems	*U*

2	Determine the trajectory of a body in a central force problem using Newton's laws	*A*
3	Understand Kepler's laws of planetary motion	*U*
4	Formulate the mathematical equation of waves	*An, A*

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	2	2	1	2	1	1
CO 2	3	3	1	2	1	1	1
CO 3	2	1	3	1	0	2	2
CO 4	1	1	2	3	1	0	2

Correlation level 0-None, 1-Slight, 2-Medium, 3-High

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1		**Non inertial Systems and Fictitious Forces**	**12**
	1	Galilean transformations	2
	2	Uniformly accelerating systems, The apparent force of gravity, Pendulum in an accelerating car	3

	3	The principle of equivalence	2
	4	Physics in a rotating coordinate system, Rate of change of a rotating vector, Acceleration relative to rotating coordinates, Time derivatives, and rotating coordinates, The apparent force in a rotating coordinate system, Fictitious Forces, The Coriolis force, Deflection of a falling mass, Motion on the rotating earth	5
		Sections 8.1 – 8.5 Book1	
2	**Central Force Motion**		**10**
	1	Central force motion as a one-body problem	2
	2	Features of central force motion, Motion is confined to a plane, Energy and angular momentum are constants of the motion, The law of equal areas, Solution for Central force problem	4
	3	The energy equation and energy diagrams	2
	4	Planetary motion- Hyperbolic orbits – Satellite orbit, Kepler‘s laws	2
		Sections 9.1-9.7 Book 1	
3	**Harmonic Oscillator & Waves**		**10**
	1	Simple Harmonic Motion, Nomenclature, Energy of the Harmonic Oscillator	2
	2	Damped harmonic oscillator – Energy and Q-factor, Graphical analysis of a damped oscillator, Solution of the equation of motion for the damped oscillator	3
	3	Waves-Progressive wave, General equation of wave motion, plane progressive harmonic wave, Energy density	3
	4	Transverse waves in stretched strings, longitudinal waves in rods, longitudinal waves in gases	2
		Sections 10.1 – 10.3 of Book 1, 11.1-11.9, 11.12 of Book 2	
4	**Special Theory of Relativity**		**13**
	1	Einstein‘s postulates, consequences of Einstein‘s postulates	2

	2	Relativity of time-relativity of length-relativistic velocity addition-relativistic Doppler effect	3
	3	Lorentz transformation-length contraction-velocity transformation-simultaneity and clock synchronization-twin paradox-space time diagram.	5
	4	Relativistic dynamics-relativistic kinetic energy-relativistic total energy and kinetic energy, -relativistic momentum and energy	3
		Chapter 2- Book 3	
5	**Practical Module**		**30**
	Directions: ***AT least 5*** *experiments from the list and 2 experiments /activities designed by the teacher*		
	1. Spectrometer –Refractive index of a prism 2. Melde‘s String- Frequency of a tuning fork/ac 3. Newton‘s law of cooling- Specific heat of a liquid 4. Potentiometer- resistance and resistivity 5. Carey Fosters Bridge- resistance & resistivity 6. Deflection Magnetometer- Tan A ,Tan B and Tan C 7. Liquid Lens –Refractive index of a liquid and material of the lens using another liquid of known refractive index 8. Simulations/virtual experiments on the topics 9. Programming and graph plotting based on the problems using any software		

Essential Readings:

1. An Introduction to Mechanics, Second Edn. – Daniel Kleppner and Robert Kolenkow – Cambridge University Press, 2014.
2. Mechanics by J C Upadhyaya 5th edn. 2017.
3. Modern Physics by Kenneth S Krane, 4th edn., 2020.

Suggested Readings:

1. Sears And Zemansky's University Physics With Modern Physics, 14^{th} Edn, Hugh D. Young, Roger A. Freedman, Addison Wessley.
2. Intermediate Dynamics, Second Edition, PATRICK HAMILL, Cambridge University Press, 2022.
3. Berkeley Physics Course : Vol.1 : Mechanics, 2^{nd} Edn. – Kittel*et al.* – McGraw-Hill, 2017.

Assessment Rubrics:

<table>
<tr><th colspan="3">Evaluation Type</th><th>Marks</th><th colspan="3">Evaluation Type</th><th>Marks</th><th>Total</th></tr>
<tr><td colspan="3">Lecture</td><td>75</td><td colspan="3">Practical</td><td>25</td><td rowspan="6">100</td></tr>
<tr><td>a)</td><td colspan="2">ESE</td><td>50</td><td>a)</td><td colspan="2">ESE</td><td>15</td></tr>
<tr><td>b)</td><td colspan="2">CCA</td><td>25</td><td>b)</td><td colspan="2">CCA</td><td>10</td></tr>
<tr><td></td><td>i</td><td>*Test Paper</td><td>10</td><td></td><td>i</td><td>Punctuality</td><td>3</td></tr>
<tr><td></td><td>ii</td><td>**Assignment/ Book-Article review</td><td>10</td><td></td><td>ii</td><td>Skill</td><td>4</td></tr>
<tr><td></td><td>iii</td><td>Seminar/ Viva-Voce</td><td>5</td><td></td><td>iii</td><td>Record</td><td>3</td></tr>
</table>

*Best out of two test papers

** or any other activities like quiz, open book exam, group activity

KU3DSCPHY211: Elementary Solid State Physics and Spectroscopy

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
III	DSC	200	KU3DSCPHY211	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture+ Tutorial	Practical	CE	ESE	Total	
3	2	35	65	100	2

Course Description:

This course provides a detailed examination of the structure and properties of solids, including crystal geometry, unit cells, and lattice structures. Students learn about the band theory of solids, focusing on electrical conduction and the classification of materials based on their energy band structures. The course also covers topics in microwave and infrared spectroscopy, exploring molecular rotation, vibrational spectra, and their applications in determining molecular properties and isotopic abundances.

Course Prerequisite: Higher secondary level Physics

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand fundamental terms of crystallography	U
2	Understand various crystal systems and crystallographic planes, miller indices	U
3	Analyse the basics of electrical conductivity in solids	An

4	Analyse the energy band structure of solids	An
5	Understand the microwave spectrum of rigid diatomic molecules and the infrared spectrum of harmonic and anharmonic systems	U

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	2	2	1	1	2	1
CO 2	3	3	1	1	1	2	2
CO 3	1	1	3	2	1	2	1
CO 4	2	1	3	2	2	2	1
CO 5	1	1	2	2	3	2	1

****Correlation level 0-None, 1-Slight, 2-Medium, 3-High***

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**Structure Of Solids**		**12**
	1	Introduction, Classification of solids, Periodicity in crystals, Crystal structure,	3
	2	Geometry of a space lattice, Unit cell, Bravais lattices, Crystal systems, Crystal symmetry, Unit cell characteristics	3
	3	Three cubic lattices, Atom positions in cubic unit cell, Directions in cubic unit cell,	3
	4	Crystallographic planes and miller indices, Interplanar distance in a cubic crystal.	3
		Book 1: Sections 16.1 - 16.11 and 16.16 - 16.19.	

2	**Band Theory of Solids**		**11**
	1	Introduction, Electrical conduction, Conductivity, Drift velocity, Influence of external factors on conductivity	3
	2	Band theory of solids, Energy bands, Energy gap,	3
	3	Classification of solids,	2
	4	Energy band structure of a conductor, Energy band structure of an insulator, Energy band structure of a semiconductor.	3
	5	**Book 1: Sections 17.1 - 17.9 and 17.13 - 17.15**	
3	**Microwave Spectroscopy**		**11**
	1	The rotation of molecules, Rotational spectra	3
	2	The rigid diatomic molecule, Determination of bond length	2
	3	The intensities of spectral lines,	3
	4	The effect of isotopic substitution, , Determination of abundance of isotopes.	3
		Book 2: Sections 19.1 - 19.7	
4	**Infrared Spectroscopy**		**11**
	1	The energy of a diatomic molecule,	3
	2	Vibrating diatomic molecule as a harmonic oscillator, The anharmonic oscillator,	3
	3	The diatomic vibrating rotator,	2
	4	The vibration rotation spectra of carbon monoxide.	3
		Book 2: Sections 20.1 - 20.5	
5	**Practical Module**		**30**
	*Directions: **At least 5** experiments from the following + 2 Activities (can be selected from the list or can be designed by the course faculty.)*		
	1. Searle's Vibration magnetometer- moment and m_1/m_2 2. Zener diode voltage regulator (V_z given) 3. Melde's string - Frequency of a tuning fork. 4. Potentiometer- Calibration of ammeter 5. Full wave Rectifier- study of ripple factor with and without filter 6. Spectrometer dispersive power of a prism 7. Newton's Ring (Radius of Curvature) given- Wavelength of Sodium light 8. Voltage multiplier 9. Simulations		

Essential Readings:

1. A textbook of Engineering Physics by M N Avadhanulu and P G Kshirsagar, S Chand & Company Ltd., 9^{th} revised edition, 2014.
2. Optics and Spectroscopy by R Murugeshan and Kiruthiga Sivaprasath, S Chand & Company Ltd., revised edition, 2010.

Suggested Readings:

1. Solid State Physics by S O Pillai, New Age International Publishers, 8^{th} edition.
2. Solid State Physics by A J Dekker, Macmillan Publishers Ltd.
3. Modern Physics by R Murugeshan and Kiruthiga Sivaprasath, S Chand & Company Ltd., 18^{th} edition.
4. Solid State Physics and Electronics by R K Puri and V K Babbar, S Chand & Company Ltd.,
5. Fundamentals of Molecular Spectroscopy by Colin N Banwell and Elaine M Mc Cash, McGraw-Hill Publishing Company, 5^{th} edition.
6. Molecular Structure and Spectroscopy by G Aruldhas, PHI Learning Private Limited, 2^{nd} edition.

Assessment Rubrics:

Evaluation Type			**Marks**	**Evaluation Type**			**Marks**	**Total**
Lecture			**75**	**Practical**			**25**	**100**
a)	**ESE**		**50**	a)	**ESE**		**15**	
b)	**CCA**		**25**	b)	**CCA**		**10**	
	i	*Test Paper	10		i	Punctuality	3	
	ii	**Assignment/ Book-Article review	10		ii	Skill	4	
	iii	Seminar/ Viva-Voce	5		iii	Record	3	

*Best out of two test papers

** or any other activities like quiz, open book exam, group activity

KU3DSCPHY212: Linear Vector Space, Matrices & Formulation of Quantum Mechanics

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
III	DSC	200	KU3DSCPHY212	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture+ Tutorial	Practical	CE	ESE	Total	
3	2	35	65	100	2

Course Description:

This course provides a mathematical foundation for Quantum Mechanics, helping the students to study the fundamental concepts of linear vector spaces, including vector operations, linear independence, basis, and dimension. Students will study linear transformations, matrix representations, eigenvalues, and eigenvectors. Emphasis is placed on solving systems of linear equations and understanding vector space applications in various fields. The course includes both theoretical insights and practical problem-solving techniques.

Course Prerequisite: Higher secondary level Mathematics and Physics

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	To apply the concept of linear vector space and Dirac notation in the formulation of quantum mechanical problems.	A
2	To understand the mathematical foundations of quantum operators and their properties.	U

3	To represent the various mathematical quantities in quantum mechanics in matrix form.	U
4	To apply the knowledge about matrices and its properties for matrix mechanics	A
5	To understand the basic postulates and principles of quantum mechanics.	An

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	3	2	3	3	2	1
CO 2	3	3	2	2	2	2	2
CO 3	3	3	2	3	2	2	1
CO 4	3	3	2	3	3	3	1
CO 5	3	3	2	2	3	2	1

Correlation level 0-None, 1-Slight, 2-Medium, 3-High

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**Mathematical Tools of Quantum Mechanics**		**10**

	1	The Linear Vector Space	2
	2	The Hilbert Space	2
	3	Dimension and Basis of a Vector Space, Examples of Linear Vector Space, Square Integrable Functions: wave Functions.	4
	4	Dirac Notation	2
		Sections 2.1-2.3 Book 1	
2	**Operators**		**12**
	1	Operators a) General Definitions b) Hermitian Adjoint c) Commutator algebra d) Inverse and Unitary Operators	4
	2	Uncertainty Relation between Two Operators	2
	3	Eigenvalues and Eigenvectors of an Operator	3
		Theorems pertaining to eigenvalue problem	
	4	Unitary Transformations and its properties	3
		Section 4 Book 1	
3	**Matrix Representation**		**13**
	1	Matrix representation of Kets and Bra	3
		Matrix representation of Operators	
	2	Some examples for matrix representation of operator (a)Hermitian adjoint operation (b) Inverse and Unitary Operators (c) Trace of an operator and its properties (d) Inner product and Outer product (e) Properties of matrix	5

	3	Matrix representation of Eigenvalue problem	3
	4	Matrix Mechanics	2
		Sections 2.5-2.7.1 Book 1	
4	**Postulates Of Quantum Mechanics**		**10**
	1	Basic Postulates of Quantum mechanics	2
	2	The state of a system, Probability Density, Superposition Principle	3
	3	Measurement in Quantum Mechanics	2
		How measurements disturb systems	
	4	Expectation values,Time evolution of expectation values	3
		Sections 3.2, 3.3, 3.5.1, 3.5.2, 3.6	
5	**Practical Module**		**30**
	*Directions: **At least 5** experiments from the following + 2 Activities (can be selected from the list or can be designed by the course faculty.*		
	1. Discuss and demonstrate following python programmes for matrix manipulation using numpy and sympy packages: ● Eigenvalue and eigen vector of a square matrix. ● Find inverse of a matrix. ● Find trace and determinant of a matrix. ● Find inner product. ● Find outer product. ● Find commutator. 2. Searle's Vibration magnetometer- moment and m1/m2 3. Voltage multiplier 4. Melde's string - Frequency of a tuning fork. 5. Potentiometer- Calibration of ammeter 6. Full wave Rectifier- study of ripple factor with and without filter 7. Spectrometer dispersive power of a prism		

	8. Newton's Ring (Radius of Curvature) given- Wavelength of Sodium light	

Essential Readings:

1. Quantum Mechanics: Concepts and Applications, N Zettili, 3rd Edn, 2009.

Suggested Readings:

1. Introduction to Quantum Mechanics, 3rd edn, David J Griffiths, Darrell F Schroeter, Cambridge University press, 2018.

Assessment Rubrics:

<table>
<tr><th colspan="3">Evaluation Type</th><th>Marks</th><th colspan="3">Evaluation Type</th><th>Marks</th><th>Total</th></tr>
<tr><td colspan="3">Lecture</td><td>75</td><td colspan="3">Practical</td><td>25</td><td rowspan="6">100</td></tr>
<tr><td>a)</td><td colspan="2">ESE</td><td>50</td><td>a)</td><td colspan="2">ESE</td><td>15</td></tr>
<tr><td>b)</td><td colspan="2">CCA</td><td>25</td><td>b)</td><td colspan="2">CCA</td><td>10</td></tr>
<tr><td></td><td>i</td><td>*Test Paper</td><td>10</td><td></td><td>i</td><td>Punctuality</td><td>3</td></tr>
<tr><td></td><td>ii</td><td>**Assignment/ Book-Article review</td><td>10</td><td></td><td>ii</td><td>Skill</td><td>4</td></tr>
<tr><td></td><td>iii</td><td>Seminar/ Viva-Voce</td><td>5</td><td></td><td>iii</td><td>Record</td><td>3</td></tr>
</table>

*Best out of two test papers

** or any other activities like quiz, open book exam, group activity

KU3DSCPHY213: Biophysics

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
III	DSC	200	KU3DSCPHY213	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture+ Tutorial	Practical	CE	ESE	Total	
3	2	35	65	100	2

Course Description:

This course provides an overview of fundamental principles and practical applications of various biophysical methods used in biochemical and biological analyses. Students will learn about the principles of photometry, calorimetry, and various spectroscopic techniques such as absorption spectroscopy and UV-visible spectrometry. Furthermore, students will explore biomechanics. Finally, the course introduces neuro biophysics.

Course Prerequisite: Higher secondary level Science

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Comprehend and apply Biophysical analytical methods them in practical scenarios for quantitative analysis of biological samples.	U, A
2	Students will gain a comprehensive understanding of diffusion and osmosis, including the causes, kinetics, and types of diffusion, as well as the mechanisms and significance of osmosis in plant and human cells.	U

3	Understand Molecular Interactions in Biological Systems	U
4	Analyse Biomechanics of Biological Movements	An
5	Understand Neuro biophysics and Sensory Mechanisms	U

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	3	3	3	3	2	2
CO 2	3	3	2	3	3	1	1
CO 3	3	3	2	3	3	2	1
CO 4	3	2	2	3	3	1	0
CO 5	3	2	2	3	3	1	2

Correlation level 0-None, 1-Slight, 2-Medium, 3-High

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**Biochemical analytical methods**		**12**
	1	Photometry, calorimetry, spectroscopies- absorption spectroscopy, spectrophotometer, ultraviolet and visible spectrometry.	3
	2	Biophysical principle: diffusion-causes of diffusion, kinetics of diffusion, types of diffusion,	3
	3	Osmosis-what is Osmosis, semipermeable membrane, mechanism of semi permeable membrane,	3
	4	Osmosis and plant cell, Osmosis and human cell	3

		Book 1: chapter 5, chapter 9	
2	**Intra and intermolecular interactions in biological system**		**13**
	1	Intra and intermolecular interaction, chemical bond, chemical behaviour of atoms, energy within atom,	4
	2	Chemical bonding and atomic orbital theory, bond length , bond energy, bond angle, bond order, chemical bonds	3
	3	Electrovalency, covalent bond, application of covalent bond, nonpolar covalent bond, polar covalent bond	3
	4	Types of Hydrogen bond, significance of Hydrogen bonding	3
		Book 2: Chapter 5	
3	**Biomechanics**		**10**
	1	Muscles-types, properties, functions, structure, molecular components of muscle.	3
	2	basic force of laws, centre of mass	2
	3	biomechanical analysis of movement of snakes	2
	4	life in fluids, swimming of fishes, aerodynamic basis of flights.	3
		Book 2: Chapter 13	
4	**Neuro Biophysics**		**10**
	1	Nervous system	3
	2	Biophysics of membrane potential, transmission of nerve impulse, Sensory mechanism	2
	3	The eye-basic structure of human eye, Biophysical aspect of vision, biophysical changes during vision.	3
	4	Ear as a hearing organ- parts of ear, Biophysical aspects of hearing.	2
		Book 2: Chapter 14	
5	**Practical Module**		**30**
	*Directions: **At least 5** experiments from the following + 2 Activities (can be selected from the list or can be designed by the course faculty.)*		
	1. Searle's Vibration magnetometer- moment and m_1/m_2 2. Zener diode voltage regulator (V_z given) 3. Melde's string - Frequency of a tuning fork.		

	4. Potentiometer- Calibration of ammeter 5. Full wave Rectifier- study of ripple factor with and without filter 6. Spectrometer dispersive power of a prism 7. Newton's Ring (Radius of Curvature) given- Wavelength of Sodium light 8. Voltage multiplier 9. Simulations	

Essential Readings:

1. A text book of Biophysics by R N Roy, 2001.
2. Introduction to Biophysics by Dr Pranab Kumar Banerjee, 2nd revised Edn., 2014.

Suggested Readings:

1. "Principles of Biochemistry" by Albert L. Lehninger, David L. Nelson, and Michael M. Cox
2. Biomechanics: Mechanical Properties of Living Tissues" by Y.C. Fung
3. Principles of Neural Science" by Eric R. Kandel, James H. Schwartz, Thomas M. Jessell, Steven A. Siegelbaum, and A.J. Hudspeth

Assessment Rubrics:

Evaluation Type			**Marks**	**Evaluation Type**			**Marks**	**Total**
Lecture			**75**	**Practical**			**25**	**100**
a)	**ESE**		**50**	a)	**ESE**		**15**	
b)	**CCA**		**25**	b)	**CCA**		**10**	
	i	*Test Paper	10		i	Punctuality	3	
	ii	**Assignment/ Book-Article review	10		ii	Skill	4	
	iii	Seminar/ Viva-Voce	5		iii	Record	3	

*Best out of two test papers

** or any other activities like quiz, open book exam, group activity.

KU3DSCPHY214 : Oscillations and waves

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
III	DSC	200	KU3DSCPHY214	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture+ Tutorial	Practical	CE	ESE	Total	
3	2	35	65	100	2

Course Description:

This course deals with the principles of harmonic motion, frictional effects, wave motion, and vibrations in various mediums. Students can understand the concepts like simple harmonic motion, damping, and driven oscillations, with applications ranging from pendulums to electrical circuits. Additionally, they study wave phenomena, including transverse and longitudinal waves, and analyze vibrations in strings, rods, and gases, gaining a comprehensive understanding of oscillatory behaviour and wave propagation in physical systems.

Course Prerequisite: Higher secondary level Physics

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Apply the ideas of simple harmonic motion to different physical situations	A
2	Analyse what causes the attenuation of waves	An
3	Understand the harmonic oscillations	U
4	Understand types of mechanical waves	U

5	Analyse the formation and properties of waves in strings, rods and gases	An

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	2	2	3	3	2	2
CO 2	3	2	2	3	2	1	1
CO 3	3	3	2	3	3	1	1
CO 4	3	2	2	3	2	1	0
CO 5	3	2	2	3	2	2	1

****Correlation level 0-None, 1-Slight, 2-Medium, 3-High***

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**Harmonic motion**		**11**
	1	Period and Harmonic motion, Harmonic oscillator, Simple harmonic motion	3
	2	Energy of a harmonic oscillator, Average values of kinetic and potential energies of a harmonic oscillator	3
	3	Examples of SHM-Compound Pendulum, Torsion pendulum,	3
	4	Two body harmonic oscillator, Oscillation of a diatomic molecule	2
		Book 1 : 7.1 -7.5;7.6-7.8	

2	**Frictional Effects**		**10**
	1	Damped Harmonic oscillator, Quality factor, Examples of damped harmonic oscillator	3
	2	Dead beat and Ballistic galvanometer	2
	3	LCR circuit	2
	4	Driven harmonic oscillator, sharpness of resonance	3
		Book 1 : 8.1,8.2,8.4,8.5-8.7	
3	**Wave Motion**		**12**
	1	Wave motion –types of waves, Transverse and longitudinal wave motion, wavefront, wavelength frequency and wave number, ,velocity and pressure curves	3
	2	Expression for a plane progressive harmonic wave, Particle velocity	3
	3	Differential equation of a wave motion, Differential equation of a three dimensional wave	3
	4	Energy density of a plane progressive wave, energy current-intensity of a wave	3
		Book 1: 9.1-9.12	
4	**Vibrations of strings, rods and gases**		**12**
	1	Vibrations of strings, Propagation of transverse vibration along a string, Velocity of a transverse wave along a string,	3
	2	Longitudinal waves in a gaseous medium,	3
	3	Longitudinal waves in rods, standing waves in a linear bounded medium	3
	4	Different modes of vibration of strings, rods and air columns	3
		Book 1: 9.15-9.21	
5	**Practical Module**		**30**
	*Directions: **At least 5** experiments from the following + 2 Activities (can be selected from the list or can be designed by the course faculty.)*		
	1. Melde's string - Frequency of a tuning fork. 2. Searle's Vibration magnetometer- moment and m1/m2 3. Potentiometer- Calibration of ammeter		

	4. Full wave Rectifier- study of ripple factor with and without filter 6. Spectrometer dispersive power of a prism 7. Newton's Ring (Radius of Curvature) given- Wavelength of Sodium light 8. Voltage multiplier 9. Simulations	

Essential Readings:

1. Mechanics - D.S. Mathur , S Chand and Company Limited, Reprint 2007.

Suggested Readings:

1. Mechanics- J C Upadhyaya, 5^{th} Edn, 2017.
2. University Physics with Modern Physics – Hugh D Young & Roger A Freedman-14^{th} edition, 2016.

Assessment Rubrics:

<table>
<tr><td colspan="3">Evaluation Type</td><td>Marks</td><td colspan="3">Evaluation Type</td><td>Marks</td><td>Total</td></tr>
<tr><td colspan="3">Lecture</td><td>75</td><td colspan="3">Practical</td><td>25</td><td rowspan="6">100</td></tr>
<tr><td>a)</td><td colspan="2">ESE</td><td>50</td><td>a)</td><td colspan="2">ESE</td><td>15</td></tr>
<tr><td>b)</td><td colspan="2">CCA</td><td>25</td><td>b)</td><td colspan="2">CCA</td><td>10</td></tr>
<tr><td></td><td>i</td><td>*Test Paper</td><td>10</td><td></td><td>i</td><td>Punctuality</td><td>3</td></tr>
<tr><td></td><td>ii</td><td>**Assignment/ Book-Article review</td><td>10</td><td></td><td>ii</td><td>Skill</td><td>4</td></tr>
<tr><td></td><td>iii</td><td>Seminar/ Viva-Voce</td><td>5</td><td></td><td>iii</td><td>Record</td><td>3</td></tr>
</table>

*Best out of two test papers

** or any other activities like quiz, open book exam, group activity

KU3DSCPHY215: Photonics & Communication

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
III	DSC	200	KU3DSCPHY215	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture + Tutorial	Practical	CE	ESE	Total	
3	2	35	65	100	2

Course Description:

This course offers an introduction to the fundamentals of photonics and its applications in modern communication systems. Topics include the properties of light, optical fibres and photonic devices. Students can understand and analyze photodetectors.

Course Prerequisite: Higher secondary level Physics

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the fundamentals of optical fibre communication	U
2	Understand and analyse various light sources for transmission	U,An
3	Understand various photo-detectors	U
4	Analyse the loss in fibre optic communication	An

******Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	2	2	2	3	2	2
CO 2	3	3	2	2	3	1	1
CO 3	3	3	2	2	3	1	1
CO 4	3	2	3	2	3	2	2

Correlation level 0-None, 1-Slight, 2-Medium, 3-High

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**Fibre Optic Fundamentals**		**12**
	1	Propagation of light in different media	3
	2	Propagation of light waves in an optical fibre, Basic structure of an optical fibre	3
	3	Acceptance angle and acceptance cone of a fibre, Numerical aperture, applications of fibres,	3
	4	Fibre classification, plastic fibres, problems	3
		Book 1, Sections 2.1 - 2.5, 2.12, 3.1 - 3.6	
2	**Light Sources for Optical Fibres**		**14**
	1	Introduction, LED, the process involved in LED's, structures of LED, LED materials,	4

	2	Output power characteristics of LED, fibre-LED coupling, modulation band width of LED, spectral emission of LED’s	3
	3	LASER operation, types of lasers, spatial emission pattern of laser, current Vs output power characteristics of a laser	3
	4	Modulation response of a laser, single frequency laser	4
		Book 1, Sections 9.1 - 9.3	
3	**Photodetectors**		**9**
	1	Introduction, characteristics of photo detectors, photo emissive photo detector	3
	2	Photoconductive devices, Photovoltaic devices	2
	3	P-N Junction photodetector, PIN photodiode, Avalanche photodiode	2
	4	Photo transistor, Bit error rate	2
		Book 1, Sections 10.1 - 10.10	
4	**Fibre Losses**		**10**
	1	Communication system general,	2
	2	Attenuation in optic fibres, material and impurity loss, Rayleigh scattering loss, Absorption loss	3
	3	leaky modes, bending loss, radiation induced loss, inherent defect loss, inverse square law loss, transmission loss	3
	4	temperature dependence of fibre loss, core and cladding loss	2
		Book 1, Sections 7.1 - 7.12	
5	**Practical Module**		**30**
	*Directions:**At least 5** experiments from the following + 2 Activities (can be selected from the list or can be designed by the course faculty.)*		
	1. Melde’s string - Frequency of a tuning fork. 3. Searle’s Vibration magnetometer- moment and m1/m2 4. Potentiometer- Calibration of ammeter 5. Full wave Rectifier- study of ripple factor with and without filter 6. Spectrometer dispersive power of a prism 7. LED characteristics		

	8. Newton's Ring (Radius of Curvature) given- Wavelength of Sodium light 9. Planck's constant using LED	

Essential Readings:

1. Optical fibres and Fibre Optic Communication Systems by Subir Kumar Sarkar, S Chand & Company Ltd. 2007.

Suggested Readings:

1. Optical Fibre Communications-Principles and Practice by John M Senior, 3rd Edition
2. Textbook on Optical Fiber Communication and its Applications by S C Gupta, 3rd Edition
3. A textbook of Engineering Physics by M N Avadhanulu and P G Kshirsagar, S Chand & Company Ltd., 9th Edition

Assessment Rubrics:

<table>
<tr><th colspan="3">Evaluation Type</th><th>Marks</th><th colspan="3">Evaluation Type</th><th>Marks</th><th>Total</th></tr>
<tr><td colspan="3">Lecture</td><td>75</td><td colspan="3">Practical</td><td>25</td><td rowspan="6">100</td></tr>
<tr><td>a)</td><td colspan="2">ESE</td><td>50</td><td>a)</td><td colspan="2">ESE</td><td>15</td></tr>
<tr><td>b)</td><td colspan="2">CCA</td><td>25</td><td>b)</td><td colspan="2">CCA</td><td>10</td></tr>
<tr><td></td><td>i</td><td>*Test Paper</td><td>10</td><td></td><td>i</td><td>Punctuality</td><td>3</td></tr>
<tr><td></td><td>ii</td><td>**Assignment/ Book-Article review</td><td>10</td><td></td><td>ii</td><td>Skill</td><td>4</td></tr>
<tr><td></td><td>iii</td><td>Seminar/ Viva-Voce</td><td>5</td><td></td><td>iii</td><td>Record</td><td>3</td></tr>
</table>

*Best out of two test papers

** or any other activities like quiz, open book exam, group activity

KU3DSCPHY216: Mathematical and Computational Modelling in Physics

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
III	DSC	200	KU3DSCPHY216	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture+ Tutorial	Practical	CE	ESE	Total	
3	2	35	65	100	2

Course Description:

This course offers a comprehensive introduction to mathematical modelling, emphasizing the transformation of physics derivations into model-building activities. Students will learn foundational principles, validate approximations, and grasp the importance of numerical solutions. The course features hands-on activities, interactive derivations, manipulable simulations, and coding exercises using WolframAlpha, as well as visualization tools like GeoGebra and NetLogo. Both physical and non-physical systems are covered, enhancing students' skills in creating models and identifying numerical solutions.

Course Prerequisite: Higher secondary level Physics

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	To understand the smooth transition from derivations to computational models.	*U*

2	To estimate the validity of approximation and simplification in mathematical modelling	*An, A*
3	To justify the importance of numerical solutions and its validity.	*An,A*
4	To examine various modelling techniques used in simple physical and non-physical systems.	*An. A*
5	To design mathematical models for simple physical systems.	*A*

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	3	2	2	3	2	2
CO 2	3	3	2	2	3	3	1
CO 3	3	3	2	2	3	3	1
CO 4	3	3	3	2	3	2	1
CO 5	3	3	2	2	3	2	2

Correlation level 0-None, 1-Slight. 2-Medium, 3-High

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS

1		**Foundations of mathematical modelling**	**15**
	1	Cognition and modelling	3
		Natural Sciences and Mathematics	
	2	Mathematical model of a body falling	4
		Principles for determining mathematical models	
	3	Analytical vs Numerical solution - Importance of computation in modelling,	4
		Basics of the numerical solution - Polynomial, Differential equation, Integration	
	4	Hands-on activity - Wolfram-alpha code on finding numerical solution of linear differential equations, solving nth order polynomial, find definite integral	4
		References: 1, 2, 5	
2		**Mathematical Modelling in Physics - Oscillations and Waves**	**10**
	1	Pendulum: simple pendulum - Physical pendulum, Viscous pendulum, Forced pendulum - resonance	3
	2	Numerical solution of the pendulum	2
	3	Deriving wave equation - wave in a string,	2
	4	Simulation of harmonic oscillator system: simple, damped, forced, piecewise and numerical solution (Hands-on activity), Interactive derivations: Wave equation, Bernoulli's equation,	3
		References: 1, 2, 3, 4	
3		**Mathematical Modelling in Physics - Other Physical Systems**	**10**
	1	Deriving Bernoulli's equation,	2
		Deriving the diffusion equation.	
	2	Modelling pressure exerted by gas and its connection with temperature,	3
		Deriving Barometric formula - Variation of atmospheric pressure with height,	
	3	Modelling heat flow: Newton's law of cooling,	2

		Heat equation.	
	4	Interactive derivations: Barometric formula, Heat equation, Hands on activity - Geogebra - Dynamic plot of the intensity of diffracted light, solving heat equation and visualising the solution using Geogebra	3
		References: 1, 2, 3, 4, 7	
4	**Mathematical Modelling: Transition from Physical system to Interdisciplinary Systems**		**10**
	1	Iconic Model Building episodes in history of physics - Blackbody radiation and Maxwell's equation	3
	2	Modelling light diffraction - single and multiple slits	2
	3	Modelling virus transmission,	2
	4	Population Dynamics.	3
		References: 1, 2, 6, 7, 8	
5	**Practical Module**		**30**
	Directions: ***At least 5*** *experiments from the following + 2 Activities (can be selected from the list or can be designed by the course faculty.)*		
	1. Searle's Vibration magnetometer- moment and m_1/m_2 2. Zener diode voltage regulator (V_z given) 3. Melde's string - Frequency of a tuning fork. 4. Potentiometer- Calibration of ammeter 5. Full wave Rectifier- study of ripple factor with and without filter 6. Spectrometer dispersive power of a prism 7. Newton's Ring (Radius of Curvature) given- Wavelength of Sodium light 8. Voltage multiplier 9. Try to discuss mathematical modelling of any 3 simple systems and use Wolfram Mathematica / Geogebra / NetLogo to find its solution / visualization.		

	For example: Reflection and transmission of light through a transparent media, Chemical kinetics equation, One species evolution, Predator-prey model, Economic competition model, Political competition, Modelling traffic, Stock Market Fluctuation, Climate Modeling, Also find the numerical solution for the model discussed. For example: Python coding to solve any 3 modelling activities and their execution.	

Essential Readings:

1. Mashood, K. K., Khosla, K., Prasad, A., Sasidevan, V., CH, M. A., Jose, C., & Chandrasekharan, S. (2022). Participatory approach to introduce computational modeling at the undergraduate level, extending existing curricula and practices: Augmenting derivations. *Physical Review Physics Education Research*, *18*(2), 020136.
2. Serovajsky, S. (2021). Mathematical Modelling (1st ed.). Chapman and Hall/CRC. https://doi.org/10.1201/9781003035602
3. Interactive Derivations - https://mcc.hbcse.tifr.res.in/interactive-derivations/
4. Manipulable Simulations - https://lsr.hbcse.tifr.res.in/manipulable-simulations/
5. Wolfram Mathematica - https://www.wolfram.com/mathematica/resources/
6. Netlogo Models Library - https://ccl.northwestern.edu/netlogo/models/
7. Geogebra resources - https://www.geogebra.org/materials
8. Branchetti, L., Cattabriga, A., & Levrini, O. (2019). Interplay between mathematics and physics to catch the nature of a scientific breakthrough: The case of the blackbody. *Physical Review Physics Education Research*, *15*(2), 020130.

Suggested Readings:

1. Sherwood, B. A., & Chabay, R. (2003). Matter and interactions.
2. Mathematical Modeling (Part 1) https://ncert.nic.in/textbook/pdf/kemh1a2.pdf
3. Mathematical Modeling (Part 2) https://ncert.nic.in/ncerts/l/iemh1a2.pdf
4. Caballero, M.D., Odden, T.O.B. Computing in physics education. *Nat. Phys.* 20, 339–341 (2024). https://doi.org/10.1038/s41567-023-02371-2

5. Hestenes, D. (1992). Modeling games in the Newtonian world. *American Journal of physics*, *60*(8), 732-748.
6. Nersessian, N. (1992). How do scientists think? Capturing the dynamics conceptual change in science.
7. Palmgren, E., & Rasa, T. (2024). Modelling Roles of Mathematics in Physics: Perspectives for Physics Education. *Science & Education*, *33*(2), 365-382.

Assessment Rubrics:

<table>
<tr><th colspan="3">Evaluation Type</th><th>Marks</th><th colspan="3">Evaluation Type</th><th>Marks</th><th>Total</th></tr>
<tr><td colspan="3">Lecture</td><td>75</td><td colspan="3">Practical</td><td>25</td><td rowspan="6">100</td></tr>
<tr><td>a)</td><td colspan="2">ESE</td><td>50</td><td>a)</td><td colspan="2">ESE</td><td>15</td></tr>
<tr><td>b)</td><td colspan="2">CCA</td><td>25</td><td>b)</td><td colspan="2">CCA</td><td>10</td></tr>
<tr><td></td><td>i</td><td>*Test Paper</td><td>10</td><td></td><td>i</td><td>Punctuality</td><td>3</td></tr>
<tr><td></td><td>ii</td><td>**Assignment/ Book-Article review</td><td>10</td><td></td><td>ii</td><td>Skill</td><td>4</td></tr>
<tr><td></td><td>iii</td><td>Seminar/ Viva-Voce</td><td>5</td><td></td><td>iii</td><td>Record</td><td>3</td></tr>
</table>

*Best out of two test papers

** or any other activities like quiz, open book exam, group activity

Employability for the Course:

Mathematical modeling is a practice that pervades all quantitative disciplines. In addition to Physics, model building finds application in all spheres where quantitative analysis and prediction are the key focus. The present course will allow students to perceive mathematical modeling from such a broad perspective which in turn will allow them to easily transition to diverse areas like finance, business analysis, quantitative social science etc. The course will give an introduction to some of the basic concepts and tools in this regard.

KU3DSCPHY217: Nanobiophysics & Biosensing

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
III	DSC	200	KU3DSCPHY217	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture+ Tutorial	Practical	CE	ESE	Total	
3	2	35	65	100	2

Course Description:

This course offers a comprehensive introduction to nanoscience and its applications in biomedicine. It begins with fundamental concepts of quantum mechanics and nanomaterials, highlighting the transition from classical to nanoscale systems. Students will explore the biomedical uses of various nanomaterials, including metallic nanoparticles, carbon-based nanostructures, and quantum dots. The course also covers the principles, types, and applications of biosensors and nanobiosensors in medical and environmental contexts. Finally, it delves into biomarkers and their critical role in disease detection, particularly in cancer diagnostics and research.

.

Course Prerequisite: Higher secondary level Physics

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand fundamental nanoscience concepts, including quantum principles and the properties of electrons, photons, and nanomaterials.	*R, U*

2	Identify the biomedical applications of nanomaterials, such as metallic nanoparticles, carbon-based nanostructures, and quantum dots in diagnostics and therapy.	*R, U, An*
3	Describe the principles and types of biosensors and nanobiosensors, and their applications in healthcare, microbiology, and environmental monitoring.	*R, U, A, An*
4	Analyse the types and roles of biomarkers in disease detection, cancer diagnostics, and biomedical research.	*R, U, A, An*

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	2	1	3	3	2	3	3
CO 2	2	1	2	3	2	2	3
CO 3	2	1	2	3	2	3	3
CO 4	1	1	2	3	2	3	3

Correlation level 0-None, 1-Slight, 2-Medium, 3-High

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**Introduction to Nanoscience**		**10**

	1	What are we talking about?, Two basic facts, Two approaches, Two key points	2
	2	From the traditional world to the quantum world, Two fundamental concepts: Wave-corpuscle duality, Probability in the quantum world	4
	3	The key players: The electron-The cornerstone of matter; Electronic states, The quantification of energy	2
	4	The photon-The wave, The energy grain, Nanomaterials.	2
	Sections 1.1, 1.2.1, 1.2.2, 1.2.3, 2.1.1, 2.1.2, 2.1.2.1, 2.1.2.2, 2.2.1.1, 2.2.1.2, 2.2.1.3, 2.2.2.1, 2.2.2.2, 2.4.3 of Book 1		
2	**Biomedical Applications of Nanomaterials**		**12**
	1	Introduction: Metallic NPs, Carbon - based nanomaterials, Fullerenes, Carbon nanotubes, Nanodiamond particles (NDP), Graphene, Quantum dots, Polymeric nanoparticles, Liposomes, Solid lipid nanoparticles	4
	2	Metallic NPs, Silver NPs and their biomedical applications, Antimicrobial properties, Therapeutics	3
	3	Gold nanoparticles and their biomedical applications, Therapeutics	2
	4	Carbon-based nanomaterials, Biosensors, Quantum dots: Properties.	3
	Sections 1.1, 1.2, 1.2.1, 1.2.1.1, 1.2.1.3, 1.2.2, 1.2.2.2, 1.3, 1.3.1, 1.4, 1.4.1 of Book 2		
3	**Basics of Biosensors and Nano biosensors**		**14**
	1	Biosensor and Its working principle, Characteristics of a biosensor: Selectivity, Reproducibility, Stability, Sensitivity and Linearity, Biosensor evolution: A brief outlook	4
	2	Types of biosensors: Electrochemical biosensors (ECBs), Potentiometric biosensors, Voltametric/Amperometric biosensors, Impedance biosensors, Conductometric biosensors	3
	3	Optical biosensors, Surface plasmon resonance, Piezoelectric biosensors, Electronic biosensors: Based on field-effect transistor, Immunosensors	4

	4	Application of biosensors, Biosensors in microbiology, Biosensors for environmental monitoring applications, Biosensors for cancer biomarker identification, Biosensor in the detection of infectious diseases	3
	Sections1.2, 1.3, 1.3.1- 1.3.4, 1.4, 1.5, 1.5.1, 1.5.1.1- 1.5.1.4, 1.5.2, 1.5.2.1, 1.5.3, 1.5.4, 1.6.2, 1.7, 1.7.1-1.7.4 of Book 3		
4	**Biomarkers and Their Role in Detection of Biomolecules**		**9**
	1	Biomarkers: Introduction, Types of biomarkers: Predictive biomarker, Prognosis biomarker, Pharmacodynamic biomarker	3
	2	Cancer biomarker, Role of biomarkers in cancer medicine	3
	3	Use of biomarkers in cancer research: Risk assessment, Screening, Diagnostic test, Staging, Monitoring tests, Types of cancer biomarkers, Biomarker of aging.	3
	Sections 4.1, 4.2, 4.2.1- 4.2.3, 4.3, 4.3.1, 4.3.2, 4.3.2.1- 4.3.2.5, 4.3.3, 4.5 of Book 3		
5	**Practical Module**		**30**
	Directions: **At least 5** experiments from the following + 2 Activities (can be selected from the list or can be designed by the course faculty.)		
	1. Newton's Ring (Radius of Curvature) given- Wavelength of Sodium light. 2. Voltage multiplier. 3. Zener diode voltage regulator (Vz given). 4. Spectrometer: Dispersive power of a prism. 5. LED characteristics. 6. Planck's constant using LED. 7. Synthesize of any nanostructure. 8. Conduct any sensing experiment. 9. Simulations/virtual experiments on the topics		

Essential Readings:

1. *An Introduction to Nanoscience and Nanotechnology,* by Alain Nouailhat (ISTE Ltd and John Wiley & Sons, Inc).

2. *Bio-Nanotechnology: A Revolution in Food, Biomedical and Health Sciences,* Edited by Debasis Bagchi, Manashi Bagchi, Hiroyoshi Moriyama, Fereidoon Shahidi (Wiley-Blackwell).
3. *Nanobiosensors: From Design to Applications,* Edited by Aiguo Wu and Waheed S. Khan (Wiley-VCH).

Suggested Readings:

1. *Nanotechnology for Bioapplications*, Edited by Bong-Hyun Jun (Springer Nature).
2. *Nanobiosensors for Personalized and Onsite Biomedical Diagnosis*, Edited by Pranjal Chandra (The Institution of Engineering and Technology, London).
3. *Biosensing using Nanomaterials*, Edited by Arben Merkoci (John Wiley & Sons, Inc.).
4. *Nanomaterials handbook*, Edited by Yuri Gogotsi (CRC Press).

Assessment Rubrics:

<table>
<tr><th colspan="3">Evaluation Type</th><th>Marks</th><th colspan="2">Evaluation Type</th><th>Marks</th><th>Total</th></tr>
<tr><td colspan="3">Lecture</td><td>75</td><td colspan="2">Practical</td><td>25</td><td rowspan="6">100</td></tr>
<tr><td>(a)</td><td colspan="2">ESE</td><td>50</td><td>(a)</td><td>ESE</td><td>15</td></tr>
<tr><td>(b)</td><td colspan="2">CCA</td><td>25</td><td>(b)</td><td>CCA</td><td>10</td></tr>
<tr><td></td><td>i</td><td>*Test Paper</td><td>10</td><td>i</td><td>Punctuality</td><td>3</td></tr>
<tr><td></td><td>ii</td><td>**Assignment/ Book Article review</td><td>10</td><td>ii</td><td>Skill</td><td>4</td></tr>
<tr><td></td><td>iii</td><td>Seminar/ Viva-Voce</td><td>05</td><td>iii</td><td>Record</td><td>3</td></tr>
</table>

*Best out of two test papers

**or any other activities like quiz, open book exam, group activity

SEMESTER IV

KU4DSCPHY203: Electromagnetics and Circuit Theory

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
IV	DSC	200	KU4DSCPHY203	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture+ Tutorial	Practical	CE	ESE	Total	
3	2	35	65	100	2

Course Description:

Electromagnetics is one of the core courses in Physics curriculum. This course covers the fundamental principles and mathematical formalism related to static electric and magnetic fields, electric potential and the analysis of electrical circuits using network theorems. After completing the course, the student should be able to appreciate principles related to electromagnetism, calculate electric and magnetic fields due to static charge configurations and steady currents and to analyse electrical circuits using network theorems.

Course Prerequisite: Basics of vector algebra, coordinates systems and calculus.

Course Outcomes:

CO No.	Expected Outcome	Learning Domains

1	Understand the fundamental principles of electrostatics and Magnetostatics and hence to establish the foundation for higher level courses in Electrodynamics, Electromagnetic waves and Radiation theory.	*U*
2	Apply appropriate mathematical methods and boundary conditions to calculate electric fields and potentials produced by static charge distributions.	*A*
3	Understand the basics of electrical circuits and analyse complex electrical circuits using network theorems.	*U, An*
4	Develop critical thinking skills through the analysis and solution of electrostatic and magnetostatic problems. Develop experimental skills through practical experiments in the laboratory.	*A*

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	3	1	1	1	1	1
CO 2	3	3	2	2	2	2	2
CO 3	1	1	3	3	2	3	1
CO 4	2	1	1	3	3	2	2

****Correlation level 0-None, 1-Slight, 2-Medium, 3-High***

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**Electric charge, Field and Potential**		**13**
	1	One Dimensional Dirac Delta Function - Three-Dimensional Dirac Delta Function	3
	2	The Electric Field - Coulomb's Law - Continuous Charge Distribution - Filed Lines - Flux and Gauss's law - Divergence of E - Applications of Gauss's Law - Curl of E	4
	3	Electric potential-Introduction to Potential - Comments on Potential - Poisson's and Laplace's Equations - Potential of a Localised Charge Distribution - Boundary Conditions	3
	4	Work and energy in electrostatics-Work done to move a charge - Energy of a point charge Distribution - Energy of a continuous charge distribution - Comments on Electrostatic Energy	3
		Sections: 1.5.2, 1.5.3, 2.1- 2.4 Book 1	
2	**Conductors**		**10**
	1	Conductors: Basic Properties - Induced Charges - Surface Charge and Force on a Conductor, Capacitors	4
	2	Potentials- Laplace's Equation in one Dimension -Laplace's Equation in two Dimension	3
	3	Approximate Potentials at Large Distances Monopole and Dipole Terms - Electric Field of a Dipole	3
		Sections: 2.5, 3.1.1, 3.1.2, 3.1.3, 3.4.1, 3.4.2 Book 1	
3	**Magnetostatics**		**12**
	1	The Lorentz Force Law: Magnetic Fields - Magnetic Forces - Cyclotron Motion - Cycloid Motion -Currents	4

	2	The Biot -Savart law: Steady Currents - Magnetic Field of a Steady Current - Straight- Line Currents - Divergence and Curl of B - Ampere's Law ,Comparison of Magnetostatics and Electrostatics	5
	3	The Vector Potential - Magnetostatic Boundary Conditions	3
		Sections: 5.1 - 5.4 Book 1	
4	**Electric Circuits**		**10**
	1	Kirchoff's Laws - Voltage and current sources - Source conversion	2
	2	Superposition theorem - Maximum power transfer theorem - Reciprocity theorem	3
	3	Thevenin's and Norton's theorems - equivalent circuits	2
	4	Star/delta, delta/star transformations	3
		Sections: 2.2, 2.15 -2.18, 2.21, 2.22, 2.25, 2.30 Book 2	
5	**Practical module**		**30**
	*Directions:**AT least 5** experiments from the list and 2 experiments /activities designed by the course faculty*		
	1. Familiarisation of Multimeter - measuring (a)AC and DC voltages (b) Resistances (c) DC currents and (d) checking electrical fuses. 2. Determine the dipole moment of a magnet M and the horizontal component of earth's magnetic field B0 at the place using a Circular Coil apparatus. 3. Calibrate the given low range voltmeter using potentiometer. 4. Searles vibration magnetometer Compare the dipole moments of the given magnets and find the dipole moment of one of them 5. Verification of Thevenin's and Norton's Theorems 6. Potentiometer- resistance and resistivity 7. Carey Foster bridge -resistance and resistivity		

Essential Readings:

1. Introduction to electrodynamics -David. J. Griffiths ,4th Edn, 2015.
2. A textbook of Electrical Technology, Volume- 1, 23rd Edn, B.L. Thereja & A.K. Thereja, 2004.

Suggested Readings:

1. Feynman Lectures Volume II
2. Classical Electrodynamics, John Davis Jackson, 3rd Edn., 2009.
3. Foundations of Electromagnetic Theory, John R. Reitz, Frederick J. Milford and Robrt W. Christy

Assessment Rubrics:

<table>
<tr><th colspan="3">Evaluation Type</th><th>Marks</th><th colspan="3">Evaluation Type</th><th>Marks</th><th>Total</th></tr>
<tr><td colspan="3">Lecture</td><td>75</td><td colspan="3">Practical</td><td>25</td><td rowspan="6">100</td></tr>
<tr><td>a)</td><td colspan="2">ESE</td><td>50</td><td>a)</td><td colspan="2">ESE</td><td>15</td></tr>
<tr><td>b)</td><td colspan="2">CCA</td><td>25</td><td>b)</td><td colspan="2">CCA</td><td>10</td></tr>
<tr><td></td><td>i</td><td>*Test Paper</td><td>10</td><td></td><td>i</td><td>Punctuality</td><td>3</td></tr>
<tr><td></td><td>ii</td><td>**Assignment/ Book-Article review</td><td>10</td><td></td><td>ii</td><td>Skill</td><td>4</td></tr>
<tr><td></td><td>iii</td><td>Seminar/ Viva-Voce</td><td>5</td><td></td><td>iii</td><td>Record</td><td>3</td></tr>
</table>

*Best out of two test papers

** or any other activities like quiz, open book exam, group activity

KU4DSCPHY204: Electronics I

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
IV	DSC	200	KU4DSCPHY204	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture+ Tutorial	Practical	CE	ESE	Total	
3	2	35	65	100	2

Course Description:

This course covers the fundamentals of semiconductor devices, including N-type and P-type semiconductors, diodes, and transistors. Students will explore diode characteristics, rectifiers, voltage regulators, and transistor biasing. Additionally, the course includes an introduction to number systems, binary arithmetic, and digital logic gates. Practical applications of Boolean algebra and logic simplification in designing combinational circuits are emphasized.

Course Prerequisite: Higher secondary level Physics

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the principles of semiconductor physics and the operation of diodes and transistors.	*U*

2	Analyse and design rectifier circuits and voltage regulators using Zener diodes.	*An, C*
3	Convert between different number systems and perform binary arithmetic.	*A*
4	Apply Boolean algebra to simplify logic circuits and design basic combinational logic circuits using NAND and NOR gates.	*A*

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	3	1	2	2	3	1
CO 2	3	3	1	1	1	2	1
CO 3	1	1	3	3	1	1	2
CO 4	1	2	3	3	2	1	1

****Correlation level 0-None, 1-Slight, 2-Medium, 3-High***

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	**UNIT**	**DESCRIPTION**	**HOURS**
1	**Semiconductor Diodes and their applications**		**10**
	1	Semiconductor Basics, N-type and P- type Semiconductors	2

	2	Diode, Biasing a Diode, Voltage – Current Characteristics of a diode, Diode Models	2
	3	Half Wave Rectifiers, Full Wave Rectifiers, Power supply Filters and Capacitor filters	3
	4	Voltage Multipliers, Zener Diodes, Zener Diode Application – Voltage Regulator.	3
		Book 1: Sections 1.6 – 1.10, 2.1 – 2.3, 2.6, 3.1 – 3.2	
2	**Transistors and Its Biasing Circuits**		**12**
	1	Bipolar Junction Transistor - Transistor Structure, Basic Transistor Operation, Transistor Characteristics and Parameters	3
	2	Transistor as an Amplifier, Transistor as a Switch	3
	3	Transistor Bias circuits – DC Operating Point, Voltage Divider Bias, Other Biasing Methods.	3
	4	Field Effect Transistor – JFET, JFET Characteristics and Parameters, JFET Biasing, MOSFET	3
		Book 1: Sections 4.1 – 4.5, 5.1-5.3, 7.1 – 7.4	
3	**Number Systems:**		**10**
	1	Decimal numbers, Binary numbers	2
	2	Decimal to Binary Conversion, Binary Arithmetic, Complements of Binary Numbers	3
	3	Signed Numbers, Arithmetic Operations with signed Numbers,	2
	4	Hexadecimal Numbers, Octal Numbers, Binary Coded Decimal (BCD), Digital Codes	3
		Book 2: Sections 2.1 to 2.11	
4	**Logic gates, Boolean algebra and Logic Simplification**		**13**
	1	The Inverter (NOT), AND, OR, NAND, NOR, Exclusive – OR and Exclusive – NOR Gates	3
	2	Boolean Operation and Expression, Laws and Rules of Boolean Algebra, DeMorgan's Theorem, Boolean Analysis of Logic Circuits, Logic Simplification using Boolean Algebra,	4
	3	Basic combinational Logic circuits	2

	4	The universal property of NAND and NOR gates, Combinational logic using NAND and NOR gates	4
		Book 2: Sections 3.1 – 3.6, 4.1 -4.7, 5.1, 5.3	
5	**Practical Module**		**30**
	*Directions: **AT least 5** experiments from the list and 2 experiments /activities designed by the course faculty*		
	1. Forward and reverse characteristics of pn junction diode. 2. Half wave and Full wave rectifier. Study ripple factor with and without filter. 3. Bridge rectifier using diode. Study ripple factor with and without filter 4. Construct Voltage multiplier circuit using diodes and capacitors 5. Zener diode characteristics, Construct a voltage regulator using zener diode. 6. Common emitter characteristics of BJT. 7. Single stage CE amplifier using transistor - gain 8. Voltage series feedback circuits using transistors 9. Realization of AND, OR and NOT gates and verify with truth table		

Essential Readings:

1. Electronic Devices, 9th Edition ,Thomas L Floyd (Pearson), 2012.
2. Digital Fundamentals , 11th Edition, Thomas L Floyd (Pearson) , 2018.

Suggested Readings:

1. Electronic Devices and Circuits David A Bell, 5th edn., 2009.
2. Electronic Devices and circuit theory - Robert L Boylestad & Louis Nashelsky (Pearson Eduaction), 2015
3. Electronic Principles - A P Malvino (TMH), 2006.
4. Basic Electronics and Linear Circuits NN Bhargava, DC Kulshreshtha and SC Gupta (Mc Graw Hill), 2nd edn., 2017.

5. Principle of Electronics, V K Metha (S Chand), 2019.
6. Digital Principles and Applications - D P Leach and A P Malvino (TMH), 2014.
7. Fundamentals of Digital Ciruits - A Anandakumar (PHI), 2016.
8. Digital Electronics circuits and Systems – V K Puri (TMH), 2017.

Assessment Rubrics:

<table>
<tr><th colspan="3">Evaluation Type</th><th>Marks</th><th colspan="3">Evaluation Type</th><th>Marks</th><th>Total</th></tr>
<tr><td colspan="3">Lecture</td><td>75</td><td colspan="3">Practical</td><td>25</td><td rowspan="6">100</td></tr>
<tr><td>a)</td><td colspan="2">ESE</td><td>50</td><td>a)</td><td colspan="2">ESE</td><td>15</td></tr>
<tr><td>b)</td><td colspan="2">CCA</td><td>25</td><td>b)</td><td colspan="2">CCA</td><td>10</td></tr>
<tr><td></td><td>i</td><td>*Test Paper</td><td>10</td><td></td><td>i</td><td>Punctuality</td><td>3</td></tr>
<tr><td></td><td>ii</td><td>**Assignment/ Book-Article review</td><td>10</td><td></td><td>ii</td><td>Skill</td><td>4</td></tr>
<tr><td></td><td>iii</td><td>Seminar/ Viva-Voce</td><td>5</td><td></td><td>iii</td><td>Record</td><td>3</td></tr>
</table>

*Best out of two test papers

** or any other activities like quiz, open book exam, group activity

KU4DSCPHY205: Optics

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
IV	DSC	200	KU4DSCPHY205	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture+ Tutorial	Practical	CE	ESE	Total	
3	2	35	65	100	2

Course Description:

This course in basics of optics will enable the student to understand various optical phenomena, principles, working and applications of optical instruments. It helps to mathematically understand the propagation and properties of light using wave equations. The course familiarises the phenomena of interference, diffraction, and polarisation.

Course Prerequisite: Higher secondary level Physics

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Recognize and use a mathematical oscillator equation and wave equation, and derive these equations for certain systems.	*U*

2	Understand the principle of superposition of waves	*U*
3	Use the principles of wave motion and superposition to explain the Physics of polarisation, interference and diffraction.	*A*
4	Understand the working of selected optical instruments like biprism, interferometer, diffraction grating, and holograms.	*U, An*

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**
CO 1	3	3	2	2	2	1	2
CO 2	3	3	3	1	2	2	1
CO 3	3	3	3	1	2	2	1
CO 4	3	2	2	2	3	1	1

Correlation level 0-None, 1-Slight, 2-Medium, 3-High

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	**UNIT**	**DESCRIPTION**	**HOURS**
1	**Two beam interference by division of wave front**		**10**
	1	Introduction- Coherence	2

	2	Interference of light waves- Young's experiment, The interference pattern-Intensity distribution.	3
	3	Fresnel biprism-Interference with white light-Displacement of fringes.	3
	4	The Lloyd's mirror- Phase change on reflection.	2
		Sections 14.1-14.6, 14.8-14.12 Book1	
2	**Interference by division of amplitude**		**10**
	1	Introduction-Interference by a parallel film when illuminated by a plane wave-The cosine law	3
	2	Non-reflecting films -Highly reflecting films by thin film deposition	2
	3	Interference by a film with two non-parallel reflecting surfaces-Colour of thin films	3
	4	Newton's Rings (reflected system)- Michelson's Interferometer-determination of wavelength of monochromatic source	2
	5	**Sections 15.1-15.4,15.5,15.7-15.11 Book1**	
3	**Fraunhofer and Fresnel Diffraction**		**13**
	1	Introduction-Single slit diffraction pattern-Position of maxima and minima. Two slit Fraunhofer diffraction pattern-position of maxima and minima , N slit diffraction pattern- position of maxima and minima-Width of principal maxima-	4
	2	The plane diffraction grating- Grating spectrum Resolving power of a grating-resolving power of a prism.	3
	3	Fresnel half period zones-Diffraction by a circular aperture-Diffraction by an opaque disc	3
	4	The zone plate- comparison between zone plate and convex lens. Diffraction by a straight edge	3
		Sections 18.1-18.2,18.6-18.8, 20.1-20.3, 20.6 Book1	
4	**Polarization and Double refraction**		**12**
	1	Introduction- Malus's law- Polarization by reflection, Brewster's law, Polarization by scattering, Nicol prism	3
	2	Superposition of two disturbances-Mathematical analysis.	3

	3	The phenomenon of double refraction-Interference of polarized lights-Quarter wave and Half wave plates-Analysis of polarized light.	4
	4	Optical activity (Qualitative ideas)	2
		Sections 22.1-22.8 Book1	
5	**Practical Module**		**30**
	*Directions: **At least 5** experiments from the list and 2 experiments /activities can be designed by the course faculty*		
	1. Spectrometer –i-d curve (Graph using software) 2. To determine dispersive power of a prism 3. Air Wedge-Diameter of a thin wire 4. Newton's Rings- wavelength of sodium light 5. Spectrometer-Cauchy's constants assuming wavelengths 6. Find the figure of merit of the given moving coil galvanometer.		

Essential Readings:

1. Optics by Ajoy Ghatak (6th Edition) -Tata MC Graw hill publishing company, 2018.

Suggested Readings:

1. A text book of Optics by Dr. N. Subramhaniam, Brijlal, Dr. M.N Avandhalu, - S Chand, 2020.
2. Optics by Eugene Hecht, 5Th edition, Pearson Education, Incorporated, 2017
3. .Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, Asia Publishing House, , 1971.
4. A Laboratory Manual of Physics for undergraduate classes, D.P.Khandelwal, VaniPub. Publishing House. 1985.

Assessment Rubrics:

Evaluation Type			Marks	Evaluation Type			Marks	Total
Lecture			**75**	**Practical**			**25**	**100**
a)	**ESE**		**50**	a)	**ESE**		**15**	
b)	**CCA**		**25**	b)	**CCA**		**10**	
	i	*Test Paper	10		i	Punctuality	3	
	ii	**Assignment/ Book-Article review	10		ii	Skill	4	
	iii	Seminar/ Viva-Voce	5		iii	Record	3	

*Best out of two test papers

** or any other activities like quiz, open book exam, group activity

SEMESTER V

KU5DSCPHY301: Electronics II

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
V	DSC	300	KU5DSCPHY301	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture + Tutorial	Practical	CE	ESE	Total	
3	2	35	65	100	2

Course Description:

This course covers the ac equivalent circuits, frequency response of BJT and fundamentals of Op-Amp and also analyse the application BJT and Op-Amp as an amplifier and oscillator. Students will explore various electronics circuits using BJT and Op-Amp. Additionally, the course includes Standard forms and simplification of Boolean Expressions and Functions of Combinational Logic.

Course Prerequisite: Electronics I

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the AC analysis of BJT circuits, Different modes amplifiers, Single stage and Multistage amplifiers and Frequency response of Amplifiers	*U , An*

2	Understand Basis of Op-Amp and Basic Op-Amp Circuits Op-Amp circuits.	*U, A*
3	Understand the feedback circuits in oscillators and different Oscillator circuits	*U, A*
4	Understand the standard forms Boolean Expressions, Functions of Combinational Logic and K map simplifications and function of Combinational logic Circuits	*U, A, An*

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	2	1	2	1	2	1
CO 2	3	2	0	2	0	2	1
CO 3	3	3	3	2	0	2	0
CO 4	2	1	2	3	2	2	1

Correlation level 0-None, 1-Slight, 2-Medium, 3-High

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	**UNIT**	**DESCRIPTION**	**HOURS**
	BJT Amplifiers		**12**
1	1	Amplifier Operation and Transistor AC Equivalent Circuits	3
	2	Common Emitter Amplifier, Common Collector Amplifier and Common Base Amplifier, Multistage Amplifiers	4

	3	Power Amplifiers – Class A Amplifiers, Class B and Class AB Push – Pull Amplifiers	3
	4	Amplifier Frequency Response – Basic Concepts - Decibel	2
	Book 1: Sections - 6.1 - 6.6, 9.1 – 9.2, 10.1, 10.2		
	Operational Amplifier and Basic Op-Amp Circuits		**10**
2	1	Introduction to Operational Amplifiers and Op-Amp Input and output Parameters	2
	2	Negative Feedback, Op-Amp with Negative Feedback and its Effect on Op Amp Impedance	2
	3	Open- Loop Response and Closed loop Response	3
	4	Basic Op-Amp circuits – Summing Amplifiers, Integrator and Differentiator	3
	Book 1: Sections – 12.1 – 12.5, 12.7 – 12.8, 13.2– 13.3		
	Oscillators		**10**
3	1	Oscillator – Feedback Oscillator Principles	3
	2	Oscillators with RC Feedback Circuits – Wien - bridge Oscillator and Phase - Shift Oscillator (OP- Amp Circuits)	3
	3	Oscillators with LC Feedback Circuits – Colpitts oscillator and Hartley Oscillator (BJT Circuits)	4
	Book 1: Sections – 16.1 – 16.4		
	Boolean Expressions and Combinational Logic		**13**
4	1	Standard Forms of Boolean Expression, Boolean Expression and Truth Tables.	2
	2	The Karnaugh Map and Karnaugh Map SOP Minimization	3
	3	Half and Full Adders, Parallel Binary Adders	3
	4	Decoders, Encoders, Multiplexer and Demultiplexer	5
	Book 2: Sections – 4.6 – 4.11, 6.1 – 6.2, 6.5, 6.6, 6.8, 6.9		
5	**Practical Module**		**30**
	*Directions: **AT least 5** experiments from the list and 2 experiments /activities designed by the course faculty*		
	1. Single stage Common Emitter amplifier - Frequency response and bandwidth		

	2. Construct Hartley Oscillator using transistor 3. Inverting amplifier, Non-inverting amplifier and voltage follower using Op-amp 4. Summing and Difference amplifier using Op-amp 5. Differentiator and Integrator using Op-amp 6. Wien Bridge Oscillator using Op-amp 7. Construct and verify Half and Full Adders 8. Minimization of a three variable Boolean expression/Truth table using Karnaugh Map and realization using NAND gates.

Essential Readings:

1. Electronic Devices, 9th Edition ,Thomas L Floyd (Pearson) , 2012.
2. Digital Fundamentals , 11th Edition, Thomas L Floyd (Pearson), 2018.

Suggested Readings:

1. Electronic Devices and Circuits David A Bell, 5th edn, 2009
2. Electronic Devices and circuit theory - Robert L Boylestad & Louis Nashelsky (Pearson Education), 2015.
3. Electronic Principles - A P Malvino (TMH), 2006.
4. Basic Electronics and Linear Circuits NN Bhargava, DC Kulshreshtha and SC Gupta (Mc Graw Hill), 2nd edn., 2017.
5. Principle of Electronics, V K Metha and Rohuth Metha(S Chand), 2019.
6. Digital Principles and Applications - D P Leach and A P Malvino (TMH), 8th edn, 2014.
7. Fundamentals of Digital Circuits - A Anandakumar (PHI), 4th edn., 2016.
8. Digital Electronics circuits and Systems – V K Puri (TMH), McGraw Hill, 2017.

Assessment Rubrics:

Evaluation Type			Marks	Evaluation Type			Marks	Total
Lecture			**75**	**Practical**			**25**	**100**
a)	**ESE**		**50**	a)	**ESE**		**15**	
b)	**CCA**		**25**	b)	**CCA**		**10**	
	i	*Test Paper	10		i	Punctuality	3	
	ii	**Assignment/ Book-Article review	10		ii	Skill	4	
	iii	Seminar/ Viva-Voce	5		iii	Record	3	

*Best out of two test papers

** or any other activities like quiz, open book exam, group activity

KU5DSCPHY302: Thermodynamics and Statistical Mechanics

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
V	DSC	300	KU5DSCPHY302	4	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture+ Tutorial	Practical	CE	ESE	Total	
4	0	30	70	100	2

Course Description:

This course helps the students to comprehend the basic concepts of thermodynamics, first law, second law of thermodynamics, PV , TS diagrams. The course covers the basics of thermodynamic potentials and phase transitions and a brief introduction to Kinetic theory and Statistical Mechanics. The course enables the students to analyse the real-life situations based on thermal properties of materials.

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the laws of thermodynamics and their importance in the nature	*U*
2	Analyse the working of heat engines with laws of thermodynamics	*An*
3	Do problems associated with heat and heat transfer	*E*

4	Understand and analyse the thermodynamic equilibrium, importance of thermodynamic potential, properties of phase transition.	*U, An*

***Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)**

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	2	1	1	1	2	1
CO 2	3	3	2	0	1	1	1
CO 3	1	0	3	0	1	1	0
CO 4	3	2	2	3	1	2	0

***Correlation level 0-None, 1-Slight. 2-Medium, 3-High**

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**Temperature and zeroth law of Thermodynamics**		**9**
	1	Macroscopic and Microscopic point of view in thermodynamic, scope of thermodynamics,	2
	2	Thermal equilibrium,	2
	3	Zeroth law, concept of temperature-measurement of temperature-thermometers, Celsius, Farenheit and Kelvin scales	3

	4	Thermodynamic equilibrium, equation of state- Examples- for ideal and real gas- hydrostatic systems – mathematical theorems – intensive and extensive parameters	2
		Book 1 sections 1.1 – 1.7,1.10-1.11,1.17,2.1-2.4,2.10	
2	**Work, heat and first law of thermodynamics**		**15**
	1	Work- Quasistatic process- work in changing volume of a hydrostatic system-PV diagram-hydrostatic work depends on path-calculation of Thermodynamic work for Quasistatic process-generalized work.	5
	2	Work & heat-Adiabatic work-internal energy function-mathematical formulation of first law-concept of heat – concept of path and state function. Meaning of Heat capacity and Specific heat Capacity.	4
	3	Differential form of first law-heat capacity & measurements – specific heat of water	3
	4	Heat reservoir- conduction- convection-radiation-black body-Kirchoff's & Stefan-Boltzmann law.	3
		Book 1 sections 3.1-3.6,3.12-3.13,4.1-4.11,4.13-4.16	
3	**The second law of thermodynamics- Entropy**		**12**
	1	Conversion of work into heat and vice-versa- principle of heat engines, cyclic process- gasoline engine and its efficiency, Diesel engine and its efficiency	3
	2	Kelvin Planck statement of second law-refrigerator; Clausius statement of second law – equivalence of both- reversibility & irreversibility.	3
	3	Concept of Entropy, Clausius Theorem. Clausius Inequality, Second Law of Thermodynamics in terms of Entropy.	3
	4	Entropy of a perfect gas. Principle of Increase of Entropy. Entropy Changes in Reversible and Irreversible processes with examples. T-S diagram and its importance.	3
		Book 1 sections 6.1-6.3, 6.6-6.14, 7.1.7.3-7.7	
4	**Thermodynamic Potentials**		**12**

	1	Thermodynamic Potentials-Internal energy, Enthalpy-Helmholtz free energy, Gibb's function- Maxwell's relations, TdS equations - applications.	3
	2	Joule Thomson expansion- JK coefficient for ideal and Vander walls gas	3
	3	Adiabatic cooling,	2
	4	first order phase transition, Clausius-Clapeyron equation & phase diagrams. Second order phase transition (Qualitative ideas).	4
		(Book 1 sections 8.1-8.2, 8.4-8.11,8.13,12.1,12.3-12.4)	
5	**Teacher Specific Module**		**12**
	Directions: Can be designed by the course faculty		
	Introduction to Kinetic theory of gases - Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas- Statistical Mechanics -MB statistics, Bose and Fermi Statistics and their applications (Qualitative).		

Essential Readings:

1. Heat and Thermodynamics-Mark W Zemanski, Richard H Dittman (8th Edn.), 2017.

Suggested Readings:

1. Modern Physics by Arthur Beiser
2. Concepts in Thermal Physics, S.J. Blundell and K.M. Blundell, 2nd Ed., 2012, Oxford University Press.
3. An introduction to Thermal Physics, Daniel V Schroeder, Oxford University Press.
4. Fundamentals of Statistical and Thermal Physics, Weily , New York
5. Basic Thermodynamics, Evelyn Guha, Narosa Publishers

Assessment Rubrics:

Evaluation Type		Marks
ESE		**70**
CCA		**30**
a)	*Test Paper	10
b)	**Assignment/ Book- Article Review	10
c)	Seminar/ Viva -Voce	10
Total		**100**

*Best out of two test papers

** or any other activities like book/article review, quiz, open book exam, group activity

KU5DSCPHY303 : Modern Physics

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
5	DSC	300	KU5DSCPHY303	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture+ Tutorial	Practical	CE	ESE	Total	
3	2	35	65	100	2

Course Description:

This course introduces atomic and nuclear physics, exploring Rutherford and Bohr atomic models, and the quantization of energy and angular momentum. Students will learn about the de-Broglie hypothesis, the wave nature of matter, and the Heisenberg uncertainty principle. The course also covers the structure of the nucleus, nuclear forces, and nuclear reactions. Additionally, it familiarizes students with elementary particles and their fundamental properties.

Course Prerequisite: Higher secondary level Physics

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand Rutherford, Bohr atom models and concept of energy and angular momentum quantisation	*U*
2	Understand de-Broglie hypothesis, concept of wave nature of matter and Heisenberg uncertainty principle	*U*

3	Understand the structure nucleus and nuclear constituents	*U, An*
4	Define nuclear forces and nuclear reactions, Familiarize elementary particles and their properties	*An*

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	3	0	1	0	1	1
CO 2	3	3	1	0	0	1	0
CO 3	1	1	3	3	3	3	0
CO 4	1	0	3	3	3	3	0

Correlation level 0-None, 1-Slight, 2-Medium, 3-High

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	**UNIT**	**DESCRIPTION**	**HOURS**
1	**Modern Physics**		**12**
	1	Particle-like Properties of Electromagnetic Radiation : Review of electromagnetic waves – Photoelectric effect – Thermal radiation	3

	2	Compton effect – Other photon processes – particles or waves	3
	3	Wavelike Properties of Particles : De Broglie hypothesis – Experimental evidences, Uncertainty relationships for classical waves – Heisenberg uncertainty relationships	4
	4	Wave packets –Motion of a wave packet, Probability, and randomness	2
		Book 1 Sections 3.1 to 3.6, Sections 4.1, 4.2.1, 4.3-4.7	
2	**Rutherford-Bohr Model of the Atom**		**10**
	1	Basic properties of atoms – Thomson model	2
	2	Rutherford nuclear atom , Line spectra	2
	3	Bohr model , Frank-Hertz experiment	3
	4	Correspondence principle ,Failure of Bohr model	3
		Book 1 Sections 5.1 to 5.8	
3	**Nuclear Physics**		**13**
	1	**Nuclear Structure and Radioactivity** Nuclear Constituents – Nuclear sizes and shapes – Nuclear masses and binding energies – Nuclear force	3
		Radioactive decay – Conservation laws in radioactive decay – Alpha decay – Beta decay – Gamma decay – Natural radioactivity	3
	2	**Nuclear Reactions and Applications** Types of nuclear reactions – Radioisotope production in nuclear reactions – Low-energy reaction kinematics	4
		Fission – Fission reactors, Fusion – Fusion processes in stars – Fusion reactors – Applications of nuclear physics	3
		Book 1; Sections 12.1 to 12.4, 12.6- 12.10, 13.1 to 13.5, 13.7.1, 13.7.2	
4	**Elementary Particles**		**10**
	1	The four basic forces Particle spectrum-Particles and antiparticles- Families of particles	4
	2	Conservation laws – Particle interactions and decays -Kinematics of particle decay-Kinematics of scattering process-Threshold energy	4

	3	The Quark Model – The Standard Model	2
		Book 1: Sections 14.1, 14.2 , 14.4-14.9	
5	**Practical Module**		**30**
	*Directions: **AT least 5** experiments from the list and 2 experiments /activities designed by the course faculty*		
	1. Laser-Slit width from diffraction pattern 2. Verification of Maximum Power Transfer Theorem 3. Spectrometer –grating-normal incidence 4. Carey Fosters‘ Bridge-Temp-coefficient of resistance 5. Conversion of Galvanometer into ammeter- calibration using potentiometer 6. Ballistic Galvanometer- high Resistance by Leakage 7. Simulations a). Frank Hertz Experiment, b). Determination of Planck's constant, c). Photoelectric effect		

Essential Readings:

1. Modern Physics (Fourth edition) by Kenneth Krane, Wiley student edition, 2020.

Suggested Readings:

1. Modern Physics by R. Murugeshan ,Er. KrithigaSivaprasath-(17 revised Edition), S.Chand,
2. Nuclear Physics by S.N.Ghoshal- S.Chand and Co
3. The Atomic nucleus by R.D Evans -McGrawHill,Newyork
4. Concepts of Modern Physics ,6thEdn–Arthur Beiser
5. Modern Physics, 3rdEdn. – Raymond A. Serway, Clement J. Moses, Curt A. Moyer – Cengage
6. Modern Physics, 2ndEdn – Randy Harris – Pearson
7. Modern Physics for Scientists and Engineers, 2ndEdn. – John R. Taylor, Chris D. Zafiratos, Michael A. Dubson – Prentice-Hall of India Pvt. Ltd.

Assessment Rubrics:

<table>
<tr><th colspan="3">Evaluation Type</th><th>Marks</th><th colspan="3">Evaluation Type</th><th>Marks</th><th>Total</th></tr>
<tr><td colspan="3">Lecture</td><td>75</td><td colspan="3">Practical</td><td>25</td><td rowspan="6">100</td></tr>
<tr><td>a)</td><td colspan="2">ESE</td><td>50</td><td>a)</td><td colspan="2">ESE</td><td>15</td></tr>
<tr><td>b)</td><td colspan="2">CCA</td><td>25</td><td>b)</td><td colspan="2">CCA</td><td>10</td></tr>
<tr><td></td><td>i</td><td>*Test Paper</td><td>10</td><td></td><td>i</td><td>Punctuality</td><td>3</td></tr>
<tr><td></td><td>ii</td><td>**Assignment/ Book-Article review</td><td>10</td><td></td><td>ii</td><td>Skill</td><td>4</td></tr>
<tr><td></td><td>iii</td><td>Seminar/ Viva-Voce</td><td>5</td><td></td><td>iii</td><td>Record</td><td>3</td></tr>
</table>

*Best out of two test papers

** or any other activities like quiz, open book exam, group activity

DISCIPLINE SPECIFIC ELECTIVES

KU5DSEPHY301: Computational Physics

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
V	DSE	300	KU5DSEPHY301	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture+ Tutorial	Practical	CE	ESE	Total	
4	0	70	30	100	2

Course Description:

This course introduces essential programming skills using Python, with an emphasis on numerical methods relevant to physics applications. The course equips students with the computational tools necessary for modelling and simulating physical phenomena.

Course Prerequisite: Basic knowledge in programming

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand basic Python concepts, including variables, operators, I/O operations, code writing, and module importing.	*U,A*
2	Understand loops, logical decision making, Python data structures and object-oriented programming.	*U, An*

3	Develop Python scripts for tasks like volume calculation, triangle area, matrix operations, and utilise NumPy and SciPy for scientific computing and 2D plotting.	*C*
4	Acquire proficiency in numerical methods, interpolation, integration, ordinary and partial differential equations, and curve fitting.	*U, A*

***Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Crea**

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	3	1	0	2	1	1
CO 2	3	3	0	1	1	0	1
CO 3	1	1	3	3	3	3	1
CO 4	1	0	3	3	3	3	0

Correlation level 0-None, 1-Slight. 2-Medium, 3-High

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**Introduction to Python Programming**		**10**
	1	Basic concepts in Python: Variables Numbers, Operators	3

	2	Typing in Python Interpreter - Namespace and Import - Python as Calculator- Types and Identities of objects	2
	3	Some built-in Functions - Numbers in Different Bases - Input and Output (I/O)	2
	4	Writing Codes - Read / Write Data - Import Modules - Creation of Numbers - Commenting	3
		Sections: 1.1 to 1.12, 1.15	
2	**Control Structures and Data Structures in Python**		**11**
	1	Loops and Logical Decision Making - For Loop - While Loop	3
	2	Function - Try Except - Python data Structures	3
	3	List - String - Tuples - Set - Dictionary	2
	4	Copy Objects - Class/Object (Introduction) - Module - package	3
		Sections: 2.1, 2.2.1, 2.2.3, 2.2.6, 2.2.8, 2.3, 3.1 to 3.5, 3.8, 4.1, 4.2, 4.3	
3	**Basic Scripting and Scientific Computing with Python**		**14**
	1	Elementary Python Scripts: Volume of a Sphere- Area of a Triangle - Odd or Even - Factorial of a Number	3
	2	Max, Min - Roots of Quadratic Equation - Infinite Series	3
	3	Matrix Operations - Numpy Arrays - Arithmetic Operations - Special Arrays - Product of Arrays - Numpy Functions	4
	4	Vectorize a Function - Polynomial in Numpy- Load and Save Data File - Scientific Python (SciPy) - Plotting in 2D	4
		Sections: 6.1 to 6.4, 6.11, 6.13, 6.16, 6.25, 7.1, 7.3, 7.7, 7.8, 7.8.1, 7.8.2, 7.9 to 7.11, 7.14, 8.1, 9.1	
4	**Numerical Methods and Computational Techniques in Python**		**13**
	1	Numerical Methods with Python - Roots of Algebraic Equation: Bisection Method - Newton-Raphson Method	3
	2	Interpolation: By Finite Difference Method - Integration: Rectangle Rule - Trapezoidal Rule - Simpson’s 1/3 Rule	3
	3	Ordinary Differential Equation (ODE): Euler’s Method - Modified Euler Method - Runge-Kutta Method	3

	4	Curve Fitting: Least Square Method - Partial Differential Equation: Wave Equation in 1D	4
		Sections: 12.1, 12.1.1, 12.1.4, 12.2, 12.2.2, 12.3.1, 12.3.2, 12.3.3, 12.4, 12.4.1, 12.4.2, 12.4.3, 12.6, 12.6.1, 12.7, 12.7.5	
5	**Teacher Specific Module**		**12**
	Directions:		
	Suggested Exercises: *1. Solution of equations by bisection method (square root of a number)* *2. Solution of equations by Newton - Raphson method (cube root of a number)* *3. Numerical Integration - Trapezoidal and Simpson's 1/3rd rule* *4. Solution of differential equation Runge - Kutta method (Harmonic Oscillator)* *5. Apply the least square method of curve fitting for a given set of data.* *6. Solve the one-dimensional wave equation by applying the initial and boundary conditions.* *7. Create two 3x3 matrices A and B with elements generated by uniform random number generator and establish the following results.* $(A+B)^T=A^T+B^T$, $(AB)^T=B^TA^T$ *8. Write a Python code to solve the given quadratic equation.* *9. Find the Mean, Variance and standard deviation for a given set of data.* *10. Create a one-dimensional Numpy array of 100 numbers between 0 and 1. Find out the maximum and replace that with 99.*		

Essential Readings:

1. Scientific Computing in Python - Abhijith Kar Gupta (2nd Edition), Techno world, 2021.

Suggested Readings:

1. Python for Informatics - Charles Severance
2. Python for Education - Ajith Kumar B.P. Numerical Methods in Engineering with Python 3 - Jaan Kiusalaas

Assessment Rubrics:

Evaluation Type		Marks
ESE		**70**
CCA		**30**
a)	*Test Paper	10
b)	**Assignment/ Book- Article Review	10
c)	Seminar/ Viva -Voce	10
Total		**100**

*Best out of two test papers

** or any other activities like quiz, open book exam, group activity

KU5DSEPHY302: Materials science

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
V	DSE	300	KU5DSEPHY302	4	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture+ Tutorial	Practical	CE	ESE	Total	
4	0	30	70	100	2

Course Description:

This course in materials science explores the fundamental properties and behaviour of materials, including metals, ceramics, polymers, and composites. Students will study the structure-property relationships and crystallography. Emphasis is placed on understanding material selection, processing, and performance in engineering applications. Students gain insights into the development and innovation of new materials for various technological advancements.

Course Prerequisite: Basic knowledge about properties of solids

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the historical context, atomic structure, bonding forces, and classification of materials.	*U*
2	Analyse crystal structures, defects, and imperfections and Bragg's Law	*An*

3	Comprehend mechanical properties, stress-strain analysis, and factors influencing material behaviour.	*An*
4	Distinguish between composite materials, ceramics, glasses, and advanced materials	*U, An*

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	2	1	1	1	1	1
CO 2	3	3	0	0	2	0	0
CO 3	3	2	3	0	2	1	1
CO 4	1	1	3	3	1	1	1

****Correlation level 0-None, 1-Slight, 2-Medium, 3-High***

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	**UNIT**	**DESCRIPTION**	**HOURS**
1	**An Introduction to Materials Science**		**11**
	1	Historical perspective, Materials Science and Engineering, Why Study Materials Science and Engineering?	3
	2	Classification of Materials, Advanced Materials; Atomic structure-Fundamental Concepts	3
	3	Electron in Atoms, Periodic Table, Bonding Forces and Energies	2
	4	Primary Interatomic Bonds (Ionic bonding, Covalent Bonding and Metallic Bonding	3

		Book 1: 1.1 -1.5, 2.1-2.6	
2	**Crystal Structure and Imperfections**		**14**
	1	Introduction, Crystal, Single Crystal, Whiskers, Space Lattice, Unit Cell, Lattice Parameters of a Unit Cell, Primitive Cell	4
	2	Types of Crystal Systems, Bravais Lattices, Metallic Structure, Body Centred Cubic Structure	4
	3	Face Centred Cubic Structure, Hexagonal Close Packed Structures, Determination of Crystal Structure, Bragg's Law.	3
	4	Defects or Imperfections in Crystals, Point Imperfections, Line Defects or Dislocations.	3
		Book 2: 3.1-3.14; 3.46- 3.47, Book 3: 3.19-3.21	
3	**Mechanical Properties of Metals**		**12**
	1	Introduction, Types of Mechanical Properties, Elasticity, Plasticity, Ductility, Brittleness, Hardness, Toughness, Stiffness, Resilience, Creep, Endurance, Strength	3
	2	Types of Strengths (elastic, plastic, tensile, compressive, shear, bending and torsional)	3
	3	Types of Technological Properties (malleability, machinability, weldability and castability)	3
	4	Factors Affecting Mechanical Properties of a Metal, Stress, Strain, Types of Stresses, Hooke's Law and Modulus of Material, Poisson's Ratio.	3
		Book 2: 6.1-6.30 and 7.1-7.6	
4	**Composite Materials and Ceramics**		**11**
	1	Introduction, Types of Composite Materials, Agglomerated Materials	3
	2	Particle Size, Packing Factor, Density and Porosity	2
	3	Cements, Setting and Hardening of Cement, Cement Concrete	3
	4	Laminated Materials, Plywood, Tufnol, Reinforced Materials, Advanced composite materials, Ceramics, Glasses.	3
		Book 2: 15.1-15.25	

5	**Teacher Specific Module**	**12**
	Directions: Activities designed by the course faculty	

Essential Readings:

1. Materials Science and Engineering' by William D. Callister, Jr.; adapted by R. Balasubramaniam, 9th Edition, 2013.
2. 'Materials Science' by R S Kurumi, R S Sedha, S Chand & Company, 2004.
3. 'Material Science' by S L Kakani and Amit Kakani, New Age International Publishers, 2016.

Suggested Readings:

1. Material Science and Engineering' by V Raghavan, 6th edn, 2015.
2. 'Modern Physical Metallurgy and Materials Engineering' by R. E. Smallman and R. J. Bishop
3. 'Solid State Physics' by M.A. Wahab, Narosa Publications, 2015.
4. 'Modern Physics' by Murugeshan, 17th edn.
5. 'Material Science and Metallurgy' by U C Jindal-Pearson Education, 2011.
6. 'An Introduction to Materials Engineering and Science for Chemical and Materials Engineers' by B.S. Mitchell, Wiley- Interscience.

Assessment Rubrics:

Evaluation Type		Marks
ESE		**70**
CCA		**30**
a)	*Test Paper	10
b)	**Assignment/ Book- Article Review	10
c)	Seminar/ Viva -Voce	10
Total		**100**

*Best out of two test papers

** or any other activities like quiz, open book exam, group activity

KU5DSEPHY303: Radiation Physics

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
V	DSE	300	KU5DSEPHY303	4	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture+ Tutorial	Practical	CE	ESE	Total	
4	0	30	70	100	2

Course Description:

This course in radiation physics covers the fundamental principles and applications of radiation, including the nature and properties of different types of radiation. Students will explore radiation interaction with matter and the biological effects of radiation. Emphasis is placed on radiation protection, providing a comprehensive understanding of radiation physics and its significance in various fields.

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the fundamental principles of radioactivity, including the definition of radioactivity and the concept of radioactive decay.	*U*

2	Differentiate between different types of radioactive emissions and explore the mechanisms involved in radioactive decay processes.	*U, An*
3	Analyse the risks and benefits associated with exposure to radioactive materials and understand the principles of radiation protection and safety measures	*An*
4	Develop experimental skills to observe and analyse radioactive decay processes and properties.	*A*

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	2	1	1	1	0	1
CO 2	3	3	2	0	2	0	1
CO 3	1	1	2	3	1	1	0
CO 4	1	1	1	3	3	1	1

Correlation level 0-None, 1-Slight, 2-Medium, 3-High

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1		**Radioactivity**	**11**
	1	Radioactivity and transformation mechanism-Alpha emission- Beta Emission-Positron Emission-Orbital electron capture	3
	2	Gamma rays- Internal conversion- Transformation kinetics	3
	3	Half Life-Average life- Activity- Specific activity	2

	4	Naturally occurring radioactivity- serial transformation.	3
		Book 2-Sec 2.1-2.4,2.7,2.8	
2		**Interaction of Radiation with Matter**	**13**
	1	Beta Rays-Range energy relationship-Mechanism of energy loss-Ionization and Excitation- Bremsstrahlung	3
	2	Alpha rays- Range energy relationship- energy transfer	3
	3	Gamma rays- Exponential Absorption-Interaction mechanisms-pair production	4
	4	Compton scattering-photoelectric absorption-Photodisintegration- combined effects	3
		Book 1-Chapter 5	
3		**Biological Effects of Radiation**	**12**
	1	Dose response characteristics-Direct action- Indirect action	3
	2	Radiation Effects- Acute effects- Delayed effects	3
	3	Relative biological Effectiveness (RBE) and Quality factor (QF)	3
	4	Dose Equivalent-High energy Radiation	3
		Book 1- Chapter 4	
4		**Radiation Protection Guides**	**12**
	1	Organisations that set standards- Philosophy of Radiation protection	2
	2	Basic Radiation Safety Criteria- Effective Dose Equivalent-Exposure of Individuals in general public- Exposure of populations- Medical Exposure- Allowable limit intake-Inhaled radioactivity -Derived air concentration-Gastrointestinal tract-Combined Exposure	4
	3	Basis for Radiation Safety Regulations- Calculation of MPC in drinking water based on dose to critical organ- Concentration in drinking water based on comparison with radium	3

	4	Airborne radioactivity- Maximum permissible concentrations for non-occupational exposure.	3
		Book 1-Chapter 8	
5	**Teacher Specific Module**		**12**
	Directions: **Radiation Detection & Measurements**		
	Radiation Detection Principle- Types of Detectors- Practical Dosimeters Solid state detectors		

Essential Readings:

1. Introduction to health physics-Herman Cember,Thomas E Johnson, 4^{th} edn., 2009.
2. Basic Radiological physics- Kuppusamy Thayalan, 2^{nd} edn., 2017.

Suggested Readings:

1. Radiation Detection and Measurement- Glenn F. Knoll
2. Introduction to Radiological Physics and Radiation Dosimetry- Frank H. Attix

Assessment Rubrics:

Evaluation Type		Marks
ESE		**70**
CCA		**30**
a)	*Test Paper	10
b)	**Assignment/ Book- Article Review	10
c)	Seminar/ Viva -Voce	10
Total		**100**

*Best out of two test papers

** or any other activities like quiz, open book exam, group activity

KU5DSEPHY304: Atmospheric Physics

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
V	DSC	300	KU5DSEPHY304	4	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture+ Tutorial	Practical	CE	ESE	Total	
4	0	30	70	100	2

Course Description:

This course explores the fundamental principles of atmospheric science, covering topics such as planetary atmospheres, thermodynamic processes, radiative transfer, and climate change. It provides a comprehensive understanding of atmospheric dynamics, radiative equilibrium, cloud formation, and the impact of human activities on climate.

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand and apply the principles of atmospheric thermodynamics, including the hydrostatic equation, adiabatic processes, and entropy.	*U*
2	Analyze radiative transfer processes in the atmosphere, including absorption, emission, and the greenhouse effect.	*An*

3	Evaluate the impact of solar radiation and its interaction with atmospheric components, such as ozone and clouds.	*E*
4	Assess climate change mechanisms, including energy balance models, climate feedbacks, and radiative forcing due to greenhouse gases.	*U*

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	3	1	1	1	0	1
CO 2	3	3	3	1	2	1	0
CO 3	3	3	3	0	1	1	1
CO 4	3	3	3	3	0	2	0

Correlation level 0-None, 1-Slight, 2-Medium, 3-High

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**Introduction to Atmospheric Physics**		**12**
	1	Planetary atmosphere, Equilibrium temperature	3
	2	Hydrostatic equation - Adiabatic rate- Sandstorm's theorem	3

	3	Radiative equilibrium model, Black body radiation - Atmospheric Windows-Absorption and emission	3
	4	Radiative equilibrium in atmosphere - Radiative time constants- Greenhouse effect	3
		.**Book 1- Section 1.1 to 1.5 , 2.1 to 2.5**	
2	**Atmospheric thermodynamics**		**14**
	1	Entropy of dry air-vertical motion of saturated air-the Tephigram - total potential energy of air column -available potential energy- Zonal & eddy energy.	4
	2	More complex radiation transfer	3
	3	Solar radiation- Its modification by scattering-Absorption of solar radiation by Ozone	3
	4	Absorption by single line-transmission of atmospheric path integral equation of transfer- Global radiation budget.	4
		Book I -Section 3.1 to 3.6 , 4.1 to 4,5, 4.11	
3	**Climate change**		**12**
	1	Introduction, An energy balance model	3
	2	Some solutions of the linearised energy balance model	3
	3	Climate feedbacks	3
	4	The radiative forcing due to an increase in carbon dioxide	3
		Book 2-Sections 8.1 to 8.5	
4	**Clouds**		**10**
	1	Cloud formation-cloud classification- Low clouds-precipitating clouds-middle clouds-high clouds	3
	2	The growth of cloud particles	2
	3	The radiative properties of clouds	2
	4	Radiation transfer in clouds, Cloud radiation feed back	3
		Book 1 -Section 6.1 to 6.5	
5	**Teacher Specific Module**		**12**
	Directions		
	Suggestions		

	Optical Features , Scattering, Indian climate, Global Warming	

Essential Readings:

1. Physics of atmosphere by John Houton (third edition Cambridge University press), 2002.
2. An Introduction to Atmospheric Physics Second Edition, David G. Andrews, Cambridge University Press, 2^{nd} edn., 2010..

Suggested Readings:

1. Introduction to theoretical Meteorology by S.L.Hess
2. An introduction to atmospheric Physics by D.G.Andrews
3. Meteorology - Understanding the atmosphere by Steven A Ackerman and John A Knox.

Assessment Rubrics:

Evaluation Type		Marks
ESE		**70**
CCA		**30**
a)	*Test Paper	10
b)	**Assignment/ Book- Article Review	10
c)	Seminar/ Viva -Voce	10
Total		**100**

*Best out of two test papers

** or any other activities like quiz, open book exam, group activity

KU5DSEPHY305: Applied Optics

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
V	DSE	300	KU5DSEPHY305	4	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture+ Tutorial	Practical	CE	ESE	Total	
4	0	30	70	100	2

Course Description:

Applied Optics explores the practical applications of light and optical technologies in various fields. This course covers the principles of light propagation, optical instrumentation, and laser systems. Students will study real-world applications such as fibre optics and photonic devices.

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the principle of light-matter interactions and laser operation and distinguish between different types of lasers	U, An
2	Understand the principle of holography and fibre technology, allowing contributions to advancements in holographic imaging and optical communication technologies.	U, An

3	Understand the fundamental principles of LEDs, enabling design and optimization of LED systems	U, An
4	Understand the principle of photoconductors and photodiodes, and their application in optoelectronics.	U

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	2	2	1	1	1	1
CO 2	3	3	2	2	2	3	0
CO 3	3	2	3	0	1	3	0
CO 4	3	3	2	0	1	1	1

Correlation level 0-None, 1-Slight, 2-Medium, 3-High

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**Lasers**		**12**
	1	Attenuation of light in an optical medium, Thermal equilibrium	3
	2	Interaction of light with matter, Einstein relations, Light amplification	3
	3	Population inversion, Active medium, Pumping Metastable states, Pumping schemes, Optical resonant cavity,	3

	4	Ruby laser, Nd:YAG laser, Helium Neon Laser, CO_2 Laser, Semiconductor laser, Q switching, Laser beam characteristics, Applications	3
		Book 1 Sections 22.1,22.8,22.10,22.11,22.14-22.17	
2	**Holography**		**12**
	1	Principle of Holography- Theory of holography- virtual image and real image	3
	2	Properties of a hologram, Advances and applications	3
	3	Optical fibre- critical angle, Modes of propagation, Acceptance angle, Fraction refractive index change, Numerical Aperture, Types of optical fibres	3
	4	Normalised frequency, Pulse dispersion, Attenuation Applications of optical fibres, Optical fibre communication system and its advantages	3
		Book 1 sections 23.2,23.5-23.7,23.9,23.10, 24.2-24.6, 24.8, 24.10-24.13, 24.15,24.16	
3	**Light Emitting Diodes**		**12**
	1	Light Emitting Diodes, Electroluminescent process, Choice of LED Materials	3
	2	Device Configuration and efficiency- injection efficiency, Recombination efficiency, Extraction efficiency and External conversion efficiency, Coupling loss,	3
	3	Light output from LED, LED structures-Heterojunction LED, BURUS Surface Emitting LED, Guided wave LED,	3
	4	Drive Circuitry, Device Performance Characteristics- Spectral response, Output power-Time characteristics, Light-Current characteristics, Diode current-voltage characteristics, Manufacturing process and Applications.	3
		Book 2- Sections 5.1-5.9	
4	**Photodetectors**		**12**
	1	Photoconductors- DC and AC photoconductor- Gain, Bandwidth and Noise in Photoconductors	3
	2	Junction photodiodes, *PIN* Photodiodes, Heterojunction diodes,	3

	3	Avalanche Photodiodes , Avalanche multiplication: ionization threshold energies, Noise performance of Avalanche Photodiodes Practical Avalanche Photodiodes, Superlattice Avalanche Photodiodes	6
		Book 2 Sections 8.2-8.4	
5	**Teacher Specific Module**		**12**
	Directions:		
	Opto- electronic devices and applications		

Essential Readings:

1. Subrahmanyam, Brijlal and Avadhanulu, A textbook of Optics, S. Chand, Multicolour Edition **, 2020.**
2. Pallab Bhattacharya, Semiconductor Optoelectronic Devices, PHI, Second Edition, 1996.

Suggested Readings:

1. *Ajoy Ghatak,* Optics, TMH, Sixth Edition, 2018.
2. *K. Thyagarajan and Ajoy Ghatak,* Lasers- Fundamentals and Applications, Springer, Second Edition, 2010.
3. *Wilson and Hawkes,* Optoelectronics, Pearson, Third Edition, 2018.
4. *S.O Kasap*, Optoelectronics and Photonics-Principles and Practices , Pearson- Second Edition, 2013.
5. *M. S Tyagi,* Introduction to Semiconductor Materials and Devices, Wiley Student Edition, 2008.
6. *Devraj Singh,* Applied Optics, PHI, 2015.
7. *M.N. Avadhanulu and PS Hemne* ,An Introduction to Lasers- theory and Applications- S Chand, Revised Edition, 2013.
8. (Journals, E-sources Websites/ weblinks)

Assessment Rubrics:

Evaluation Type		Marks
ESE		**70**
CCA		**30**
a)	*Test Paper	10
b)	**Assignment/ Book- Article Review	10
c)	Seminar/ Viva -Voce	10
Total		**100**

*Best out of two test papers

** or any other activities like quiz, open book exam, group activity

SEMESTER VI

KU6DSCPHY304: Electrodynamics-I

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VI	DSC	300	KU6DSCPHY304	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture+ Tutorial	Practical	CE	ESE	Total	
3	2	35	65	100	2

Course Description:

This course discusses effects of polarisation, Gauss's law analysis, Ampere's law. It also helps the students to know more about electromagnetic induction and electromagnetic wave propagation.

Course Prerequisite: Electrostatics higher secondary level

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the effects of polarization on bound charges, analyze Gauss's Law in dielectrics, solve boundary value problems with linear dielectrics, and quantify energy and forces in dielectric systems.	*U, An, A*
2	Explain magnetization processes, apply Amperes Law in magnetized media, differentiate between linear and nonlinear magnetic materials, and explore the properties of ferromagnetism.	*A, An*

3	Apply Ohm's Law and electromotive force, analyze electromagnetic induction and Maxwell's equations, explore conservation laws and continuity equations, and understand electromagnetic potentials and gauge transformations.	*A, An*
4	Describe wave propagation in different media, analyze wave reflection and transmission, calculate energy and momentum in electromagnetic waves, and apply wave equations and boundary conditions to understand wave behaviour.	*An, C*

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	2	1	1	1	1	1
CO 2	3	2	1	0	2	1	0
CO 3	3	3	2	1	1	2	0
CO 4	3	2	2	1	0	1	1

Correlation level 0-None, 1-Slight, 2-Medium, 3-High

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**Electric Fields and Dielectrics**		**10**

	1	Polarization – Bound charges – Physical interpretation of bound charges – The field inside a dielectric	3
	2	Gauss's law in the presence of a dielectric - Boundary Conditions- Displacement vector	3
	3	Linear dielectrics –Susceptibility –permittivity – dielectric constant – Boundary value problems with linear dielectrics	2
	4	Energy in dielectric systems –Force on dielectrics – Clausius-Mossotti equation.	2
		Sections: 4.1- 4.4	
2	**Magnetization and Magnetic Materials**		**10**
	1	Magnetization – Torques and forces on magnetic dipoles –Effect of a magnetic field on atomic orbits	3
	2	Magnetization –The field of a magnetized object –Bound currents – Physical interpretation of bound currents	2
	3	The magnetic field inside matter – The auxiliary field H– Amperes law in Magnetized material	2
	4	Boundary Conditions-Linear and Nonlinear Media – Magnetic susceptibility and permeability –Ferromagnetism	3
		Sections: 6.1 –6.4	
3	**Electrodynamics and Maxwell's Equations**		**15**
	1	Ohm's law - Electromotive force – Motional e.m.f - electromagnetic induction-Induced electric field - Inductance –self-inductance and mutual inductance –Inductance of coupled coils	4
	2	Energy in a magnetic field –Electrodynamics before Maxwell – How Maxwell fixed Ampere's law– Maxwell's equations – 'Magnetic charge' –Maxwell's equations inside matter – boundary conditions	4
	3	Conservation laws – Charge and energy – The continuity equation – Poynting's theorem- Newton's third law in electrodynamics	4
	4	Potential formulations of electrodynamics – Scalar & vector potentials – Gauge transformations – Coulomb Gauge and Lorenz Gauge	3
		Sections: 7.1 –7.3, 8.1 – 8.2.1, 8.2.3, 8.2.4, 10.1	
4	**Electromagnetic Waves and Propagation**		**10**

	1	The wave equation in one dimension – Sinusoidal waves –Boundary conditions – Reflection and transmission	3
	2	Polarization - Electromagnetic waves in vacuum – The wave equation for E & B –Monochromatic plane waves	3
	3	Energy and momentum in electromagnetic waves –Propagation in linear media	2
	4	Reflection and transmission at normal incidence	2
		Sections: 9.1 – 9.2, 9.3.1, 9.3.2	
5	**Practical Module**		**30**
	Directions: ***AT least 5*** *experiments from the list and 2 experiments /activities designed by the course faculty*		
	1. Deflection Magnetometer & Box type vibration magnetometer- m and B0 2. Lee‘s disc- Thermal conductivity of a bad conductor 3. Potentiometer-Calibration of High range voltmeter (Graph using software) 4. Potentiometer-Reduction factor of TG and B0(Error analysis is required) 5. Calibrate the given ammeter using Potentiometer. 6. Ballistic Galvanometer- absolute capacity of a capacitor		

Essential Readings:

1. Introduction to electrodynamics -David. J. Griffiths , 4th Edn, 2013.

Suggested Readings:

1. Feynman Lectures Volume II
2. Classical Electrodynamics, John Davis Jackson, 3rd Edn., 2009.
3. Foundations of Electromagnetic Theory, John R. Reitz, Frederick J. Milford and Robrt W. Christy

Assessment Rubrics:

<table>
<tr><th colspan="3">Evaluation Type</th><th>Marks</th><th colspan="3">Evaluation Type</th><th>Marks</th><th>Total</th></tr>
<tr><td colspan="3">Lecture</td><td>75</td><td colspan="3">Practical</td><td>25</td><td rowspan="6">100</td></tr>
<tr><td>a)</td><td colspan="2">ESE</td><td>50</td><td>a)</td><td colspan="2">ESE</td><td>15</td></tr>
<tr><td>b)</td><td colspan="2">CCA</td><td>25</td><td>b)</td><td colspan="2">CCA</td><td>10</td></tr>
<tr><td></td><td>i</td><td>*Test Paper</td><td>10</td><td></td><td>i</td><td>Punctuality</td><td>3</td></tr>
<tr><td></td><td>ii</td><td>**Assignment/ Book-Article review</td><td>10</td><td></td><td>ii</td><td>Skill</td><td>4</td></tr>
<tr><td></td><td>iii</td><td>Seminar/ Viva-Voce</td><td>5</td><td></td><td>iii</td><td>Record</td><td>3</td></tr>
</table>

*Best out of two test papers

** or any other activities like quiz, open book exam, group activity

KU6DSCPHY305 : Solid State Physics and Spectroscopy

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VI	DSC	300	KU6DSCPHY305	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture+ Tutorial	Practical	CE	ESE	Total	
3	2	35	65	100	2

Course Description:

Solid-state physics and spectroscopy course includes the properties and behaviours of solid materials through the principles of quantum mechanics, crystallography, and electronic structure. This course covers the fundamentals of crystal lattices, band theory, and the interaction of electromagnetic radiation with matter. Students will explore various experimental methods such as microwave and infrared spectroscopy.

Course Prerequisite: Higher secondary level Physics

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand basic crystal structure and compare various crystal systems	*U*
2	Understand and analyse Bragg's law and X-ray diffraction method	*U, An*

3	Analyse the properties of semiconductors and band structure of solids	*An*
4	Understand the microwave and infrared spectroscopy	*U*

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	2	1	1	1	2	1
CO 2	3	3	1	0	2	1	1
CO 3	2	2	3	0	1	0	0
CO 4	1	1	1	3	1	1	0

Correlation level 0-None, 1-Slight. 2-Medium, 3-High

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**Structural Study of Crystalline Solids**		**13**

	1	Introduction – Lattice points and space lattice – The basis and crystal structure – Unit cells and lattice parameters – Unit cell versus primitive cell	4
	2	Crystal systems – Symmetry elements in crystals – Metallic crystal structures SC, BCC, FCC and HCP structures	3
	3	Directions, planes and Miller indices – Important features of Miller indices -	3
	4	Bragg's law – Bragg's X Ray Spectrometer – Powder crystal method – Rotating Crystal method	3
		Book 1 Chapter 4, Sections 1-16, 18-19; Chapter 5, Sections 7-11	
2	**Semiconducting Properties of Materials**		**12**
	1	Semiconductors – Intrinsic and extrinsic semiconductors – Band structure of semiconductors	3
	2	Fermi level of intrinsic and extrinsic semiconductors - Fermi level and carrier concentration in semiconductors	3
	3	Mobility of charge carriers – Electrical conductivity in semiconductors	3
	4	Hall Effect – Applications of Hall effect.	3
		Book 2 Chapter 13, Sections 1-4, 6; Book 1 Chapter 5, Section 14	
3	**Microwave Spectroscopy**		**10**
	1	Regions of the spectrum-Microwave spectroscopy	2
	2	The rotation of molecules-Rotational spectra-The rigid diatomic molecule	3
	3	Intensities of spectral lines-The effect of isotopic substitution	2
	4	The non rigid rotator- The spectrum of a non rigid rotator, Microwave oven.	3

		Book 3 Chapter 1, Section 3; Book 3 Chapter 2, Sections 1-3, 7	
4	**Infrared Spectroscopy**		**10**
	1	The vibrating diatomic molecule-The energy of diatomic molecule	2
	2	The Simple Harmonic Oscillator - The Anharmonic Oscillator	3
	3	The diatomic Vibrating Rotator	2
	4	The vibration-rotation spectrum of carbon monoxide	3
		Book 3 Chapter 3, Sections 1-3	
5	**Practical Module**		**30**
	*Directions: **AT least 5** experiments from the list and 2 experiments /activities designed by the course faculty*		
	1. Spectrometer –i-i' curve (Graph using software) 2. Spectrometer –grating- minimum deviation 3. Power amplifier (Class A) using transistor - Frequency response and band width 4. Voltage series and Current series Feedback circuits using transistors 5. Astable Multivibrator using transistors 6. Conversion of Galvanometer into voltmeter- calibration using potentiometer 7. Simulations		

Essential Readings:

1. Solid State Physics by S O Pillai, New Age International Publishers, 8th Edition (2018)

2. Solid State Physics, Structure and Properties of Materials by M A Wahab, Narosa Publishing House, 2nd Edition (2005)

3. Fundamentals of Molecular Spectroscopy by Colin N. Banwell and Elaine M. Mc Cash, Tata McGraw-Hill Publishing Company Ltd., 5th Edition.

4. A Text Book of Optics by N Subrahmanyam, Brijlal and Dr. M.N Avadhanlu, 25th revised Edition (2006)

Suggested Readings:

1. Introduction to Solid State Physics, Charles Kittel, Wiley and Sons, 8th Edition.
2. Solid state Physics, Saxena, Guptha, Mandal, Pragathi Prakashan
3. Solid State Physics by J.Dekker, MacMillan India Ltd
4. Elementary Solid State Physics by M. A. Omar, Pearson Education
5. Introduction to Spectroscopy, Donald L Pavia Cengage Learning Pvt Ltd
6. Molecular Structure and Spectroscopy by G Aruldhas, PHI, 2nd Edition (2008)

Assessment Rubrics:

Evaluation Type			**Marks**	**Evaluation Type**			**Marks**	**Total**
Lecture			**75**	**Practical**			**25**	**100**
a)	**ESE**		**50**	a)	**ESE**		**15**	
b)	**CCA**		**25**	b)	**CCA**		**10**	
	i	*Test Paper	10		i	Punctuality	3	
	ii	**Assignment/ Book-Article review	10		ii	Skill	4	
	iii	Seminar/ Viva-Voce	5		iii	Record	3	

*Best out of two test papers

** or any other activities like quiz, open book exam, group activity

KU6DSCPHY306: Quantum Mechanics-I

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VI	DSC	300	KU6DSCPHY306	4	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture+ Tutorial	Practical	CE	ESE	Total	
4	0	30	70	100	2

Course Description:

This course will equip students with a solid understanding of foundational concepts in quantum mechanics, enabling them to analyse and solve a variety of quantum systems. Also, it delves into the solutions of the Time Independent Schrödinger Equation within one- dimensional systems, focuses on solving the Schrödinger equation for the Hydrogen atom, one of the fundamental systems in quantum mechanics and introduces the mathematical framework necessary for understanding quantum mechanics.

Course Prerequisite: Modern Physics

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the foundations of quantum mechanics, Identify the admissibility conditions on wave functions and comprehend the concepts of eigenfunctions and eigenvalues. Explain the postulates of quantum	U

	mechanics and comprehend the principle of simultaneous measurability of observables.	
2	Analyze one-dimensional energy eigenvalue problems, Understand the principles behind scanning tunnelling microscopy and its application	U, An
3	Explore the quantum mechanics of the hydrogen atom, including solving the Schrödinger equation, identifying quantum numbers. Analyze experimental evidence supporting quantum mechanics.	U, An
4	Gain proficiency in the mathematical tools of quantum mechanics,	A

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	2	0	2	2	1	0
CO 2	3	2	0	2	3	1	0
CO 3	3	2	0	2	2	1	0
CO 4	3	3	0	2	3	1	0

****Correlation level 0-None, 1-Slight, 2-Medium, 3-High***

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
	Eigen Functions and Eigen Values		12
	1	Time Independent Schrodinger Equation- Stationary states-Admissibility Conditions on the Wave functions	3
	2	Eigen Functions and eigen values	3
	3	Postulates of Quantum Mechanics	3
	4	Simultaneous Measurability of observables.	3
		Book 1-Chapter 2 &3	
2	**One Dimensional Energy Eigenvalue Problems**		**11**
	1	Square well potential with rigid walls- square well potential with finite walls- square potential barrier	3
	2	Tunnel effect-Alpha emission- Scanning Tunneling Microscope	3
	3	Linear Harmonic Oscillator	2
	4	Schrodinger method- Free particle	3
		Book 1-Chapter 4	
3	**Hydrogen Atom**		**13**
	1	Schrodinger equation for Hydrogen atom-separation of variables	3
	2	Quantum numbers-Principal Quantum Number, Orbital Quantum number, Magnetic Quantum number-	4
	3	Zeeman Effect-electron spin- Exclusion Principle	3
	4	Stern Gerlach Experiment.	3
		Book 3- Chapter 6 &7	

Module	Unit	Content	Hrs
4		**Mathematical Tools of Quantum Mechanics**	**12**
	1	Hibert Space and Wave Functions	3
	2	Dirac notation-Operator	3
	3	Representation in discrete bases	3
	4	Representation in continuous bases	3
		Book 2-Chapter 2	
5		**Teacher Specific Module**	**12**
		Directions: Suggestions	
		1. Symmetric and Antisymmetric wave functions 2. Spin orbit Coupling 3. Total Angular Momentum 4. X-ray Spectra 5. Paschen- Back Effect 6. The Stark effect	

Essential Readings:

1. Quantum Mechanics- G Aruldhas, 2nd edn., PHI, 2008.
2. Nouredine Zettili, Quantum Mechanics- Concepts and Applications, 3rd edn., 2009.
3. Concepts of Modern physics- Arthur Beiser, 6th edn, McGraw Hill, 2020.

Suggested Readings:

1. Quantum Physics of Atom, Molecules, Solids, Nuclei & Particles-R. Eisberg &R. Resnick
2. Modern Physiscs- Kenneth S Krane, 4th edn., Wiley India, 2020.
3. Quantum Mechanics- B H Bransden & C J Joachain

Assessment Rubrics:

Evaluation Type		Marks
ESE		**70**
CCA		**30**
a)	*Test Paper	10
b)	**Assignment/ Book- Article Review	10
c)	Seminar/ Viva -Voce	10
Total		**100**

*Best out of two test papers

** or any other activities like quiz, open book exam, group activity

DISCIPLINE SPECIFIC ELECTIVES

KU6DSEPHY306: Biophotonics

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VI	DSE	300	KU6DSEPHY306	4	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture+ Tutorial	Practical/ Internship	CE	ESE	Total	
4	0	30	70	100	2

Course Description:

This course provides a comprehensive understanding of photonics and biophotonics. It covers the principles of nonlinear optics, including wave propagation, second harmonic generation, and stimulated Raman scattering. Students will explore the diverse applications of biophotonics, focusing on light absorption and interaction with biological cells and tissues. Additionally, the course delves into the use of various optical fibres in biophotonic applications and the mechanisms of light-tissue interactions, such as scattering and photobiomodulation.

Course Prerequisite: Optics

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand and apply fundamental concepts and phenomena in nonlinear optics, including second harmonic generation and stimulated Raman scattering.	*U, A*

2	Explain the diverse applications and spectral properties of biophotonics, and analyse the structure and interaction of light with biological cells and tissues.	*U, An*
3	Describe the principles and performance characteristics of various optical fibres, and evaluate their suitability for specific biophotonic applications.	*U, E*
4	Understand and analyse the mechanisms of light-tissue interactions, including reflection, absorption, scattering, and fluorescence, and their applications in biomedical fields.	*U, An*

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	2	1	1	1	1	0
CO 2	3	3	1	1	1	2	1
CO 3	3	3	3	0	1	1	1
CO 4	3	3	2	2	0	1	1

****Correlation level 0-None, 1-Slight, 2-Medium, 3-High***

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**Non-Linear Optics**		**12**

	1	Introduction; Wave Propagation and Momentum Conservation	3
	2	Linear Medium; Nonlinear Polarization	3
	3	Second Harmonic Generation; Phase Matching; Sum and Difference Frequency Generation	3
	4	Parametric Oscillation; Self-Focussing of Light; Stimulated Raman Scattering	3
		Book 1 sections 25.1- 25.10	
2	**Overview of Biophotonics**		**10**
	1	What is biophotonics-diverse applications-biophotonics	2
	2	spectral windows-light absorption – signal attenuation-	2
	3	structures of biological cells and tissues- Macromolecules- biological cells- mitochondria	3
	4	biological tissues and organs	3
		Book 2 sections 1.1 – 1.6	
3	**Optical Fibres for Bio photonic Applications**		**13**
	1	Light Guiding Principles in Conventional Optical Fibres; Ray Optics Concepts; Modal Concepts, Mode Field Diameter, Effective Refractive Index;	4
	2	Graded-Index Optical Fibres; Core Index Structure, Graded-Index Numerical Aperture, Cutoff Condition in Graded-Index Fibres;	3
	3	Performance Characteristics of Generic Optical Fibres	3
	4	Double-Clad Fibres; Coated Hollow-Core Fibres; Photonic Crystal Fibres; Side-Emitting or Glowing Fibres; Middle-Infrared Fibres; Tapered Optical Fibres	3
		Book 2 Sections 3.1, 3.1.1, 3.1.2, 3.1.3, 3.1.4 , 3.2, 3.2.1, 3.2.2, 3.2.3, 3.3, 3.6, 3.8, 3.9, 3.11, 3.12, 3.13	
4	**Light – Tissue Interactions**		**13**
	1	Reflection and Refraction Applications- Refraction in Ophthalmology, Specular Reflection, Diffuse Reflection	3

	2	Absorption- Absorption Characteristics, Absorption in Biological Tissues	3
	3	Scattering- Elastic scattering, Rayleigh scattering, inelastic (Raman) scattering	3
	4	Light-Tissue Interaction Mechanisms – Photo biomodulation, Photochemical Interaction, Thermal Interaction, Photoablation, Plasma-Induced Photoablation, Photo disruption; Fluorescence Basics	4
		Book 2 sections 6.1,6.1.1,6.1.2,6.1.3; 6.2,6.2.1,6.2.2; 6.3,6.3.1,6.3.2,6.3.4; 6.5,6.5.1,6.5.2,6.5.3,6.5.4,6.5.5,6.5.6; 6.7	
5	**Teacher Specific Module**		**12**
	Directions		
	Discussion on Bio photonic devices		

Essential Readings:

1. A textbook of Optics; N Subramanyam, Brijlal and M.N.Avadhanulu; S.Chand, 25 th Edition Publishing, 2020.
2. Biophotonics: Concepts to Applications by Gerd Keiser, 2nd edn., 2022.

Suggested Readings:

1. Optics by Ajoy Ghatak
2. Geometrical and Physical optics by P.K.Chakroborthy
3. Introduction to Biophotonics" by Paras N. Prasad
4. "Principles of Biomedical Optics" by Lihong V. Wang
5. "Handbook of Biomedical Optics" edited by David A. Boas, Colin J.R. Sheppard, and Valery V. Tuchin
6. Lasers Theory and Applications - K. Thyagarajan and AK Ghatak – Macmillan India
7. "Nonlinear Optics" by Robert W. Boyd:

Assessment Rubrics:

Evaluation Type		Marks
ESE		**70**
CCA		**30**
a)	*Test Paper	10
b)	**Assignment/ Book- Article Review	10
c)	Seminar/ Viva -Voce	10
Total		**100**

*Best out of two test papers

** or any other activities like quiz, open book exam, group activity

KU6DSEPHY307: Nanoscience

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VI	DSE	300	KU6DSEPHY 307	4	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture+ Tutorial	Practical	CE	ESE	Total	
4	0	30	70	100	2

Course Description:

This course is meant to the study, manipulation of matter in the nanometre scale. Material properties such as the optical, electrical, thermal, and mechanical properties change drastically in the atomic or molecular regime as compared to the corresponding bulk matter.

Course Prerequisite: Basic knowledge of condensed matter, interparticle interactions in solids

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand basic concepts of Nanoscience	*U*
2	Differentiate the properties of bulk materials and Nanomaterials	*U*
3	Identify various methods of synthesis of nanoparticles	*U*
4	Understand Characterization techniques	*U*

5	Applications of Nanomaterials in daily life and Scientific world	*A*

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	2	1	1	1	1	1
CO 2	3	2	0	0	0	0	1
CO 3	2	3	3	1	1	0	1
CO 4	1	1	3	3	1	1	0
CO 5	1	1	1	1	3	1	1

Correlation level 0-None, 1-Slight. 2-Medium, 3-High

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**Introduction To Nanoscience**		**10**
	1	Nano And Nature	3
	2	Our technologies and the world we live in	3
	3	NANO- The beginning	4
		Book 1, Chapter 1, sections 1.1-1.3	
2	**Properties Of Materials In The Nano-Regime**		**14**

	1	Effect of size reduction on bulk materials- size effect on physical properties	4
	2	Optoelectronic properties of bulk and nanostructures-relation between optical properties and electronic structure	4
	3	Electronic structure and fermi surface- electron-phonon coupling	3
	4	Luminescence from nanoparticles, Thermodynamics of nanoparticles	3
		Book 2, Chapter 2, Sections 2.7-2.10 & 2.12	
3	**Synthesis And Characterization Of Nanomaterials**		**13**
	1	Bottom Up approach- Sol-gel technique-	4
	2	Top Down approach- ball milling-lithography	3
	3	Crystallography	3
	4	Transmission Electron Microscopy, Field Ion Microscopy	3
		Book 2, Chapter 4, Section 4.4 & Book 3, Chapter 3, Sections 3.2.2, 3.3.1,3.3.2	
4	**Applications Of Nanotechnology**		**11**
		Material Science, Biology And Medicine	3
		Energy and Environment	3
		Carbon Nanotechnology: Carbon nanostructures and Applications	3
		fullerene, Carbon nanotube, Graphene	2
		Book 2, Chapter 10, Sections 10.1 to 10.5 & 10.8	
5	**Teacher Specific Module**		**12**
	Illustration of nanoparticle synthesis and characterization methods depending on the availability of corresponding instruments		

Essential Readings:

1. Nano : The Essentials , T. Pradeep, Tata-McGraw Hill Publishers 2007
2. Nanoscience and Nanotechnology: Fundamentals to Frontiers, M S Ramachandra Rao, Shubra Sing, Wiley India Pvt. Ltd.. 2013.
3. Introduction to Nanotechnology, Charles Poole Jr. and Frank J. Owens, John Wiley and Sons 2003

Suggested Readings:

1. Nanostructures and Nanomaterials-Synthesis, Properties and Applications, Guzhong Cao, Imperial College Press
2. Introduction to Nanoscience and Nanotechnology, K K Chathopadhyay, A Banerjee, PHI Learning Pvt. Ltd

Assessment Rubrics:

<table>
<tr><th colspan="3">Evaluation Type</th><th>Marks</th><th colspan="3">Evaluation Type</th><th>Marks</th><th>Total</th></tr>
<tr><td colspan="3">Lecture</td><td>75</td><td colspan="3">Practical</td><td>25</td><td rowspan="6">100</td></tr>
<tr><td>a)</td><td colspan="2">ESE</td><td>50</td><td>a)</td><td colspan="2">ESE</td><td>15</td></tr>
<tr><td>b)</td><td colspan="2">CCA</td><td>25</td><td>b)</td><td colspan="2">CCA</td><td>10</td></tr>
<tr><td></td><td>i</td><td>*Test Paper</td><td>10</td><td></td><td>i</td><td>Punctuality</td><td>3</td></tr>
<tr><td></td><td>ii</td><td>**Assignment/ Book-Article review</td><td>10</td><td></td><td>ii</td><td>Skill</td><td>4</td></tr>
<tr><td></td><td>iii</td><td>Seminar/ Viva-Voce</td><td>5</td><td></td><td>iii</td><td>Record</td><td>3</td></tr>
</table>

*Best out of two test papers

** or any other activities like quiz, open book exam, group activity

KU6DSEPHY308: Medical Imaging & Diagnostic Techniques

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VI	DSE	300	KU6DSEPHY308	4	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture+ Tutorial	Practical	CE	ESE	Total	
4	0	30	70	100	2

Course Description:

This course introduces students to the physics of various techniques used in medical imaging. This course provides an in-depth exploration of advanced diagnostic imaging techniques, covering the principles and applications of X-ray production, body section radiography, computerised tomography (CT), ultrasound, digital radiography, and magnetic resonance imaging (MRI). Students will delve into the construction of diagnostic X-ray tubes, interaction between X-rays and matter, principles of tomography and stereoscopy, and the fundamentals of CT, ultrasound, digital radiography, and MRI. Through theoretical study students will gain a comprehensive understanding of cutting-edge imaging technologies in the medical field.

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains

1	Understand the principles of X-ray production and its interaction with matter.	*U*
2	Explore advanced techniques in body section radiography, including tomography and stereoscopy.	*An*
3	Gain proficiency in the principles and applications of computerized tomography (CT) and ultrasound imaging.	*An*
4	Familiarize with digital radiography systems and techniques, including digital fluoroscopy and digital subtraction.	*U*
5	Develop an understanding of magnetic resonance imaging (MRI) principles, image reconstruction, and safety considerations.	*U*

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	2	0	1	1	1	2
CO 2	3	2	0	0	1	1	2
CO 3	3	2	2	1	0	2	1
CO 4	3	2	2	2	1	1	0
CO 5	3	2	1	1	1	0	0

****Correlation level 0-None, 1-Slight, 2-Medium, 3-High***

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1		**X-ray**	**12**
	1	Production-Diagnostic X-ray tube construction-Grid controlled X-ray tube- Saturation voltage-Heel effect- Tube rating-Process of X-ray Generation	3
	2	Body Section Radiology-Stereoscopy-Neuroradiology (Book 1 Chapter 16, 17 &18) Interaction between X-ray and matter-Coherent Scattering-Photoelectric effect- Compton Scattering- Pair production	3
	3	Attenuation-Linear and mass attenuation coefficient-Factors affecting attenuation application to diagnostic radiology	3
	4	Filters-inherent and added filters-Heavy metal filters(Book 1 Chapter 6)-Xray beam restrictors-aperture diaphragm-cones and cylinders-collimators-function of restrictor (Book1 Chapter 7). (9 hours)	3
		Book 1:Chapter 2,3,4,6,7,16,17,18	
2		**Ultrasound**	**12**
	1	Physical characteristics of sound-characteristics of ultrasound beam-Transducers-Piezoelectric Crystals. Characteristics of an ultrasonic beam- interaction of ultrasound and matter-quarter wave matching-	3
	2	Basic physics of sound propagation in different media, half and quarter wavelength, transmission of pulse and echo modes,	3
	3	Ultrasonic display-, A, B and TM scanning modes.	3
	4	Imaging Principle-Doppler Ultrasonography- Real-Time Ultrasound	3
		Book 1 Chapter 20	
3		**Computerized Tomography (CT)**	**11**
	1	Historical background-Basic Principle-Data accumulation, various generations of scanners, Image reconstruction	3

	2	Comparison of mathematical methods-Image quality-Patient Exposure- Artifacts -3D Imaging	3
	3	Digital Radiography: Digital Fluoroscopy System- Digital Image Processor-Digitized Image-Image Noise	2
	4	Quantum Mottle. Digital Subtraction Techniques-Temporal Filtering -Digital Image Processing	3
		Book 1 Chapter 19, Chapter 22	
4	**NMR-Magnetic Resonance Imaging**		**13**
	1	History- Electron Angular Momentum-Nuclear Angular momentum-Magnetism	3
	2	Alignment of magnetic moment in a magnetic field-Larmor precession-	3
	3	NMR parameters- Mechanism for Relaxation-Instrumentation-NMR Spectrum.	3
	4	MRI: Basics of MRI- Spin Echo sequence- Image Reconstruction-Mult slice Imaging- Mult echo Imaging- Contrast-Signal to noise ratio-Fast Imaging Techniques- Safety Considerations.	4
		Book 1 Chapter 23&24	
5	**Teacher Specific Module**		**12**
	Directions		
	Body Section Radiology-Stereoscopy-Neuroradiology		

Essential Readings:

1. Christensen's Physics of Diagnostic Radiology (Lea & Febiger), 4^{th} edn,1990.
2. Fundamental Physics of Radiology, W.J.Meredith and J.B. Massey, 3^{rd} Edn., 1983.

Suggested Readings:

1. First year Physics for Radiographers Hay & Hughes (ELBS).
3. Basic Medical Radiation Physics Stantor (Appleton-Century & Crofts).
4. X-ray Equipment for student Radiographers By: Chesney & Chesney (Blackwell).
5. Manual of Radiographic equipment. By: Sybil M. Stockley (Churchill Livingstone).

6. Principles of Diagnostic X-ray apparatus by: Hill (Macmillan.).
7. Radiologic science for Technologist Stewart C. Bushong, (M Mosby.).

Assessment Rubrics:

Evaluation Type		Marks
ESE		**70**
CCA		**30**
a)	*Test Paper	10
b)	**Assignment/ Book- Article Review	10
c)	Seminar/ Viva -Voce	10
Total		**100**

*Best out of two test papers

** or any other activities like quiz, open book exam, group activity

KU6DSEPHY309 : Astrophysics

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VI	DSE	300	KU6DSEPHY309	4	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture+ Tutorial	Practical	CE	ESE	Total	
4	0	30	70	100	2

Course Description:

This course gives a pedagogical introduction to astronomy and astrophysics by introducing the students the techniques to measure astronomical parameters, the properties of the Sun, stellar evolution and properties of galaxies and an overview of the Universe.

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Demonstrate a deep understanding of theoretical frameworks in astronomy, including celestial mechanics, stellar structure, and cosmology.	*U*
2	Understand stellar classifications and basic concepts of birth of the star. Analyse the theory of death of the star Define white dwarf, neutron star and black hole	*U,An*

3	Expose scientific knowledge about the origin and evolution of the universe.	*An*
4	Describe the morphology and classification of galaxies and galaxy clusters. Expose scientific knowledge about the origin and evolution of the universe.	*U*

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	2	1	1	1	0	1
CO 2	3	2	1	0	1	1	0
CO 3	3	2	3	3	0	2	1
CO 4	3	2	3	3	0	0	0

****Correlation level 0-None, 1-Slight, 2-Medium, 3-High***

COURSE CONTENTS

Contents for Classroom Transaction:

M O D U L E	U N I T	DESCRIPTION	HOURS
1	**Basic Tools of Astronomy**		**14**
	1	Stellar Magnitude Sequence - Absolute Magnitude and the Distance Modulus - The Bolometric Magnitude - Different Magnitude Standards: The UBV System and Six-colour Photometry - Radiometric Magnitudes - The Colour-index of a Star	5
	2	Luminosities of Stars - Stellar Parallax (Trigonometric) and the Units of Stellar Distances - Stellar Positions: The Celestial Coordinates – Horizontal system - Equatorial system - The Ecliptic System	3
	3	Harvard system of spectral classification: the henry-draper (hd) catalogue - The Luminosity Effect on Stellar Spectra	3
	4	Importance of Ionization Theory in Astrophysics - Spectroscopic Parallax - The Hertzsprung-Russell Diagram	3
		Book 1 sections 3.1 - 3.9 ; 4.4-4.8	
2	**Stars**		**14**
	1	Star clusters, Red Giants and the H-R Diagram	3
	2	The Death of Stars-The Asymptotic Giant Branch- Dredge-Ups- Mass Loss and Stellar Winds	4
	3	Infrared Stars-The End of an AGB Star‘s Life.- White Dwarf Stars- High-Mass Stars and Nuclear Burning - The End Result of High-Mass Stars	4
	4	Evolution: Pulsars, Neutron Stars, and Black Holes	3

		Book 2 sections 3.11, 3.14-3.19, 3.21, 3.21.1, 3.21.2, 3.21.3, 3.21.4, 3.22, 3.24.1, 3.24.2	
3	**Galaxies**		**10**
	1	The Milky Way, Open star clusters, Globular clusters, The interstellar medium and emission nebulae	3
	2	Size, shape and structure of the Milky Way, A super-massive black hole at the heart of our galaxy	3
	3	Other galaxies, Elliptical galaxies, Spiral galaxies, Evidence for an unseen component in spiral galaxies – dark matter, Irregular galaxies	2
	4	The Hubble classification of galaxies, Active galaxies, Groups and clusters of galaxies, Superclusters,	2
		Sections 8.1-8.3, of Book 3	
4	**The Universe**		**10**
	1	The structure of the universe	2
	2	Big Bang models of the universe, The expansion of the universe.	3
	3	The cosmological redshift, The steady state model of the universe, Big Bang or Steady State	2
	4	The cosmic microwave background, The discovery of the cosmic microwave background, Inflation, Formation of the primeval elements	3
		Sections 9.2-9.9 Book 3	
5	**Teacher Specific Module**		**12**
	Directions		

	Basic equations of stellar structure , Hydrostatic equilibrium in stars - *Central pressure and temperature of the Sun-* Virial theorem for stars Some relations amongst stellar quantities, Main sequence, red giants and white dwarfs, The ends of the main sequence. Eddington luminosity limit HR diagrams of star clusters 4.3 Important nuclear reactions in stellar interiors	

Essential Readings:

1. An introduction to astrophysics (second Edition) Baidyanath Basu,Tanuka Chattopadhyay, Sudhindra Nath Biswas PHI Learning Private Limited, 2010.
2. Astrophysics is Easy: An introduction for the Amateur Astronomer- Mike Ingis- Springer
3. Introduction to Astronomy and Cosmology by Ian Morison, John Wiley & Sons, 2008

Suggested Readings:

1. The physical universe: An introduction to astronomy, F.Shu, Mill Valley: University Science Books.
2. Modern Astrophysics, B.W. Carroll & D.A. Ostlie, Addison-Wesley Publishing Co.
3. Astrophysics for Physicists - Arnab Rai Choudhuri – Cambridge University Press

Assessment Rubrics:

Evaluation Type		**Marks**
ESE		**70**
CCA		**30**
a)	*Test Paper	10
b)	**Assignment/ Book- Article Review	10
c)	Seminar/ Viva -Voce	10
Total		**100**

*Best out of two test papers

** or any other activities like quiz, open book exam, group activity

KU6DSEPHY310 : Plasma and Space Physics

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VI	DSE	300	KU6DSEPHY310	4	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture+ Tutorial	Practical	CE	ESE	Total	
4	0	30	70	100	2

Course Description:

This course provides a comprehensive introduction to plasma physics and its applications, covering fundamental principles, kinetic theory, wave behaviour, instabilities, and the role of plasma in space weather phenomena.

Course Prerequisite: Basics of Electrodynamics

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Define plasma, analyse Debye shielding, assess plasma parameters, determine criteria for plasma, and recognise applications in plasma physics.	*R. An*
2	Proficiently understand single particle motions in diverse electric and magnetic field scenarios and derive and analyse fluid equations. Apply the plasma approximation for simplified modelling.	*U, A*

3	Comprehend plasma oscillations, electron plasma waves, sound waves, and ion waves; compare ion and electron waves; study equilibrium and stability.	*An*
4	Students will possess a comprehensive understanding of space weather.	*U, An*

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	3	2	2	1	0	1
CO 2	3	3	2	1	0	1	0
CO 3	3	3	3	1	0	1	1
CO 4	3	3	2	3	3	1	0

Correlation level 0-None, 1-Slight, 2-Medium, 3-High

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**Introduction to Plasma Physics**		**12**
	1	Occurrence of plasma in nature	3
	2	Definition of plasma- Debye shielding	3
	3	The plasma parameters - Criteria for plasma	3
	4	Applications of plasma physics	3

		Book-1 Sections: 1.1, 1.2, 1.4, 1.5 to 1.7	
2	**Plasma Kinetics and Fluid Dynamics**		**13**
	1	Single particle motions: Uniform E and B fields- Nonuniform B field - Nonuniform E field	4
	2	Time varying E field - Time varying B filed	3
	3	Plasma as fluid- Comparison with ordinary hydrodynamics- Equation of continuity- Equation of state	3
	4	The complete set of fluid equations - The plasma approximation	3
		Book-1 Sections: 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 3.1, 3.3.4 to 3.3.7, 3.6	
3	**Plasma Waves and Instabilities**		**13**
	1	Plasma oscillations - Electron plasma waves	3
	2	Sound waves - Ion waves - Comparison of ion and electron waves	3
	3	Equilibrium and stability - Hydromagnetic equilibrium - Classification of instabilities	3
	4	Streaming instabilities - Rayleigh Taylor instabilities - Universal instabilities- Kinetic instabilities	4
		Book-1 Sections: 4.3, 4.4 to 4.6, 4.8, 6.1, 6.2, 6.5, 6.5.1 to 6.5.4	
4	**Space Plasma and Space Weather**		**10**
	1	Space weather- Introduction- Impacts of space weather on society	2
	2	The heliosphere- The corona and the solar wind - The interplanetary magnetic field - Coronal mass ejections -The outer heliosphere	3
	3	Cosmic rays - Earth's space environment - Dipole magnetic field - Structure of the inner magnetosphere	3
	4	Interaction of the solar wind and magnetosphere - Magnetic reconnection - The magnetotail	2
		Book-2 Sections: 1.2, 1.4, 3.2 to 3.7, 4.1 to 4.7	
5	**Teacher Specific Module**		**12**
	Directions:		
	Course faculty can design the content		

Essential Readings:

1. Introduction to Plasma Physics and Controlled Fusion, Third Edition, Francis F. Chen, 2016.
2. An Introduction to Space Weather, Mark Moldwin , 2 edn., 2022.

Suggested Readings:

1. Fundamentals of Plasma Physics, Third Edition, J. A. Bittencourt
2. Introduction to Space Physics by Margaret G. Kivelson and Christopher T. Russell

Assessment Rubrics:

Evaluation Type		Marks
ESE		**70**
CCA		**30**
a)	*Test Paper	10
b)	**Assignment/ Book- Article Review	10
c)	Seminar/ Viva -Voce	10
Total		**100**

*Best out of two test papers

** or any other activities like quiz, open book exam, group activity

SEMESTER VII

KU7DSCPHY401: Mathematical Physics

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VII	DSC	400	KU7DSCPHY401	4	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture+ Tutorial	Practical/ Internship	CE	ESE	Total	
4	0	30	70	100	2

Course Description:

The course covers mathematical techniques essential for advanced studies in physics . It begins with a thorough exploration of special functions and orthogonal polynomials, providing a foundational understanding of these mathematical tools. Complex analysis is then introduced. Fourier series and transforms are examined next, offering insights into representing periodic and non-periodic functions. Finally, the course concludes with a study of systems of ordinary and partial differential equations, along with an introduction to tensor analysis, essential for modelling physical phenomena in diverse fields.

Course Prerequisite: Basic Mathematical physics

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Master special functions and orthogonal polynomials. Students will learn how these functions and polynomials are used to solve problems in physics.	*U, An*

2	Understand and analyze Fourier series and Fourier transforms, including their properties and applications in physics.	*U, An*
3	Develop a foundational understanding of complex numbers and functions including properties, analytical methods, and complex integration and able to apply these concepts to the study of electrodynamics and quantum mechanics.	*A, E*
4	Develop expertise in ordinary and partial differential equations, and solve PDEs, with a specific focus on systems of DEs, their applications in physics	*An, E*

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	2	2	1	0	0	1
CO 2	3	3	2	0	1	1	0
CO 3	2	2	3	0	1	1	1
CO 4	2	2	2	3	3	1	1

****Correction level 0-None, 1-Slight, 2-Medium, 3-High***

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**Special Functions and Orthogonal Polynomials**		**13**
	1	Gamma and Beta Functions , The factorial function , Definition and properties of the Gamma function ,The Gamma function of negative numbers, Definition and properties of the Beta function, Relationship between Gamma and Beta functions	3
	2	Legendre Polynomials- Introduction to Legendre polynomials , Legendre's equation, Rodrigues' formula, Generating function for Legendre polynomials, Recursion relations, Orthogonality of Legendre polynomials , Normalization of Legendre polynomials, Associated Legendre polynomials	4
	3	Bessel Functions - Introduction to Bessel functions, Solutions of Bessel's differential equation , The second solution of Bessel's equation, Graphs and zeros of Bessel functions, Recursion relations, Differential equations with Bessel function solutions, Orthogonality of Bessel functions, Other kinds of Bessel functions - Neumann functions and Hankel functions, Spherical Bessel functions.	4
	4	Hermite and Laguerre Polynomials - Introduction to Hermite polynomials, Generating function for Hermite polynomials, Orthogonality of Hermite polynomials , Introduction to Laguerre polynomials, Generating function for Laguerre polynomials, Orthogonality of Laguerre polynomials, Associated Laguerre polynomials	3
		(Book 2-Chapter 11, Chapter 12)	
2	**Complex Analysis**		**14**

	1	**Complex Numbers and Functions** -Definitions and properties of complex numbers, Definition and examples of analytic functions , Cauchy-Riemann equations , Laplace's Equation - Harmonic functions Trigonometric and Hyperbolic Functions, Analyticity of the logarithm	4
	2	**Complex Integration-**Line integrals in the complex plane, Cauchy's integral theorem, Cauchy's integral theorem for multiply connected domains, Cauchy's integral formula, Derivatives of analytic functions, Liouville's theorem and the maximum modulus principle	4
	3	**Complex Power Series -** Definition and examples of complex power series ,Operations on complex power series, Taylor and Maclaurin series	3
	4	**Laurent Series - Residue Integration-** Laurent Series, Singularities and Zeros, Zeros of analytic functions, Residue integration method, Residue theorem, Residue integration of real integrals	3
	5	**Book 1- Chapters 13,16,18**	
3	**Fourier Series and Transforms**		**10**
	1	**Fourier Series** - Introduction to the Fourier series, Conditions of convergence, Fourier series for even and odd functions, Half-range Fourier series, Sturm-Liouville problems – eigenvalues, eigenfunctions. Orthogonality.	5
	2	**Fourier Integrals** - Fourier integral, Applications of Fourier Integrals, Fourier sine and cosine integrals, Fourier sine and cosine transforms, Inverse Fourier transforms , Convolution theorem	5
		Book 1, Chapter 11	
4	**Differential Equations**		**11**

	1	**Partial Differential Equations-** Partial Differential Equations (PDEs) , Basic Concepts of PDEs , Laplace's equation - steady state temperature in a rectangular plate and solution by separation of variables.	3
	2	Heat Equation- Derivation of the heat equation, Solution by the method of separation of variables, use of Fourier series , Steady two-dimensional heat problems - Laplace's equation, Insulated boundaries.	4
	3	**Introduction to Tensor Analysis-** Definition of tensors, tensor notations, summation convention, contraction, Symmetric and antisymmetric tensors, quotient rule, Kronecker delta and the Levi-Civita symbol, Pseudo vectors and pseudo tensors. Cross product, Non-Cartesian tensors. Contravariant and covariant vectors. Basis vectors. Metric tensor, Physical applications of tensors, moment of inertia tensor, electric polarisation.	4
		Book 1- Chapter 4, Book 2- Chapter 13,10	
5	**Teacher Specific Module**		**12**
	Directions		
	1. Applications of beta and gamma functions - the simple pendulum, Stirling's formula, Elliptic integrals 2. Applications Legendre function in electrostatics, quantum mechanics (angular part of the wavefunction in spherical coordinates) 3. Applications of Bessel Functions in wave propagation, heat conduction, and vibrations of circular membranes 4. Applications of Hermite and Laguerre function in quantum mechanics (harmonic oscillator, wavefunctions of the hydrogen atom) 5. Applications Fourier series and integrals in physics: forced oscillations, vibrating string, solving PDEs and Power Spectrum (Physical Interpretation), Discrete and Fast Fourier Transforms		

Essential Readings:

1. Advanced Engineering Mathematics (10th Edn.), Erwin Kreyzing, John Wiley, 2011.
2. Mathematical Methods in the Physical Sciences (3rd Edn.), Mary L. Boas, Cambridge University Press, 2006.

Suggested Readings:

1. Mathematical Methods for Physicists, Arfken & Weber (7th edition), Academic Press.
2. Mathematical Methods for Physics and Engineering (3rd Edn.), K.F. Riley, M.P. Hobson, and S.J. Bence, CUP, 2006.
3. Mathematical Methods for Physicists: A Concise Introduction, Tai L. Chow, CUP.
4. A Student's Guide to Fourier Transforms, JFJ James, CUP
5. A Student's Guide to Vectors and Tensors, Daniel Fleisch, CUP
6. A Primer on Scientific Programming with Python, Langtangen, H.P, Springer.

Assessment Rubrics:

Evaluation Type		Marks
ESE		**70**
CCA		**30**
a)	*Test Paper	10
c)	** Assignment/ Book-Article Review	10
d)	Seminar/ Viva -Voce	10
Total		**100**

*Best out of two test papers

* or any other activities like quiz, open book exam, group activity

KU7DSCPHY402:Classical Mechanics

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VII	DSC	400	KU7DSCPHY402	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture+ Tutorial	Practical	CE	ESE	Total	
3	2	35	65	100	2

Course Description:

The primary objective of this course is to introduce students to some of the advanced formulations of mechanics such as Lagrangian, Hamiltonian and Hamilton-Jacobi formulations and hence enable them to understand how these methods paved the way for developing conceptual as well as mathematical framework for quantum mechanics. Students will receive a strong grounding in these methods, enabling them to apply those concepts in many other fields of physics.

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Deal with particle mechanics at an advanced level. Use the calculus of variations to characterise the function that extremizes a functional.	*U, An*

2	Understand the concept of constraints, principle of least action and formulation of Lagrange's method and apply Lagrange's equation for simple dynamical systems. Understand Central force and its application in Kepler's problem.	*U, A*
3	Formulate and solve problems in classical mechanics using the Lagrangian, Hamiltonian and Hamilton-Jacobi formulations.	*A, E*
4	Apply the methods of classical mechanics to identify conserved quantities and normal modes.	*A*
5	Analyse motion of rigid bodies in non-inertial frames of reference using Euler angles and Euler's equations.	*An*

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	2	1	1	1	1	1
CO 2	3	3	2	1	0	1	1
CO 3	2	2	3	1	0	0	1
CO 4	2	2	3	3	1	1	0
CO 5	2	2	2	2	3	1	0

Correlation level 0-None, 1-Slight, 2-Medium, 3-High

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**Lagrangian Formulation**		**13**
	1	Constraints, Principle of virtual work, D'Alembert's principle and Lagrange's equations, Simple applications of the Lagrangian formulation,	3
	2	Hamilton's principle, Some techniques of the calculus of variations, Derivation of Lagrange's equations from Hamilton's principle	3
	3	Euler-Lagrange differential equations, Conservation theorems and symmetry properties (qualitative treatment only)-Cyclic coordinates.	3
	4	The Central force problem-Reduction to the equivalent one-body problem, The equations of motion and first integrals, Classification of orbits, The Kepler problem.	4
		Sections 1.3, 1.4, 1.6, 2.1, 2.2, 2.3, 2.6, 3.1, 3.2, 3.3, 3.7 of Book 1	
2	**Hamiltonian Formulation**		**11**
	1	The Hamiltonian function, Legendre transformations and the Hamilton's equations of motion-Phase space,	3
	2	Canonical transformations-Equations of canonical transformation, Examples of canonical transformations, The harmonic oscillator,	3
	3	Poisson brackets and other canonical invariants, Hamilton's equation in Poisson bracket form,	3
	4	Poisson's theorem, Infinitesimal canonical transformation, The angular momentum Poisson bracket relations	2
		Sections 8.1, 9.1, 9.2, 9.3, 9.5, 9.6, 9.7 of Book 1	
3	**Hamilton-Jacobi Formulation**		**11**

	1	Hamilton-Jacobi equations-Hamilton's principal and characteristic functions, The one-dimensional harmonic oscillator problem as an example of the Hamilton-Jacobi method	3
	2	The Hamilton-Jacobi equation for Hamilton's characteristic function, Action angle variables-linear harmonic oscillator.	3
	3	**Small Oscillations:** Formulation of the problem-Stability analysis-Lagrange's equations of motion for small oscillations	2
	4	The Eigen value equation, Frequencies of free vibrations and normal co-ordinates, Free vibrations of a linear triatomic molecule.	3
		Sections 10.1, 10.2, 10.3, 10.6 , 6.1, 6.2, 6.3, 6.4 of Book 1	
4	**Rigid Body Dynamics**		**10**
	1	The independent co-ordinates of a rigid body-Euler angles, Infinitesimal rotations, Rate of change of a vector	3
	2	Centrifugal and Coriolis forces, The inertia tensor and the moment of inertia	2
	3	The Eigen values of the inertia tensor and the Principal axis of transformation,	3
	4	The Euler's equation of motion, Torque free motion of a rigid body	2
		Sections 4.1, 4.4, 4.8, 4.9, 4.10, 5.3, 5.4, 5.5, 5.6 of Book 1	
5	**Practical Module**		**30**
	*Directions: **AT least 6** experiments from the list and 2 experiments /activities designed by the course faculty*		
	1. Vibrating strip – Mode constants 2. Cornu's elliptical fringes – Determination of Y, σ and K with glass. 3. Cauchy's constants - Determination of Cauchy's constants - λ sodium light 4. Rydberg constant – by spectrometer and diffraction grating 5. Quincke's method – Susceptibility of a liquid at 2 different concentrations		5

	6. LASER –fundamental experiments- diameter of thin wire, Determination of wavelength using 7. a diffraction grating, Determination of refractive index of mirror substrate 8. Maxwell’s L.C.Bridge – Determination of resistance and inductance of a given coil 9. Lee’s Disc – K of liquid/powder and air using thermocouple & B.G 10. Young’s modulus of different materials using strain gauge 11. Cauchy’s constants of liquids using hollow prism and spectrometer 12. Anderson’s bridge - Self-inductance 13. Meyer’s oscillating disc – Viscosity of Liquid	

Essential Readings:

1. Herbert Goldstein, Charles P. Poole and John Safko: “Classical Mechanics” (3rd Edition, Pearson Education, 2011)

Suggested Readings:

1. T. Thornton and J B. Marion, Classical Dynamics of Particles and Systems, Cengage.
2. R. G. Takwale and P. S. Puranic, Introduction to Classical Mechanics, TMH.
3. N. C. Rana and P. S. Joag, Classical Mechanics, TMH.
4. G. Aruldhas, Classical Mechanics, PHI.
5. V. B. Bhatia, Classical Mechanics, Narosa Publishers.
6. Gupta, Kumar and Sharma, Classical Mechanics, Pragati Prakashan.
7. J.C. Upadhyaya, Classical Mechanics, Himalaya Publishing House.
8. A K Raychaudhari, Classical Mechanics: A Course of Lectures, OUP.
9. Schaum’s outline Series on “Theoretical Mechanics” by Murray R Spiegel
10. NPTEL Lecture Series on Classical Physics by Prof. V. Balakrishnan, Department of Physics, IIT Madras.
11. NPTEL Video Course-Classical Mechanics-From Newtonian to Lagrangian Formulation, Prof. Debmalya Banerjee.

Assessment Rubrics:

Evaluation Type			Marks	Evaluation Type			Marks	Total
Lecture			**75**	**Practical**			**25**	**100**
a)	**ESE**		**50**	a)	**ESE**		**15**	
b)	**CCA**		**25**	b)	**CCA**		**10**	
	i	*Test Paper	10		i	Punctuality	3	
	ii	**Assignment/ Book-Article review	10		ii	Skill	4	
	iii	Seminar/ Viva-Voce	5		iii	Record	3	

*Best out of two test papers

** or any other activities like book/article review, quiz,open book exam, group

KU7DSCPHY403: Quantum Mechanics II

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VII	DSC	300	KU7DSCPHY403	4	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture+ Tutorial	Practical	CE	ESE	Total	
4	0	30	70	100	3

Course Description:

This course provides students with a comprehensive understanding of the foundational principles, mathematical tools, and approximation methods essential for advanced studies in quantum mechanics. It explores the foundational principles and mathematical frameworks of quantum mechanics, focuses on the theory of angular momentum- a fundamental concept in quantum mechanics, explores the role of symmetry and conservation laws in quantum mechanics, and covers approximation methods for solving stationary state problems in quantum mechanics.

Course Prerequisite: Expertise in Mathematical methods

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the fundamental postulates of quantum mechanics and the various formulations of the equation of motion, Comprehend the uncertainty principle and analyse the time development of wave packets in quantum mechanics	*U, An*

2	Understand the theory of angular momentum, the matrix representation and eigenfunctions of angular momentum. Analyse the addition of angular momenta.	*U, An, A*
3	Analyse systems of identical particles and understand the symmetries and conservation laws associated with them,	*An*
4	Understand the approximation methods for stationary states, the variational principle and its application. Evaluate the WKB approximation method	*U, E,A*

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	2	1	1	1	1	1
CO 2	3	3	1	1	1	2	0
CO 3	2	2	3	0	0	1	1
CO 4	2	2	0	3	1	0	2

Correlation level 0-None, 11-Slight, 2-Medium, 3-High

COURSE CONTENTS

Contents for Classroom Transaction:

MODU	UNIT	DESCRIPTION	HOURS

L E			
1	**The Formulation of Quantum Mechanics**		**12**
	1	Fundamental Postulates	3
	2	The Equation of Motion-Schrodinger, Heisenberg and Interaction pictures	3
	3	Uncertainty Principle- Wave packet and its time development	3
	4	Linear Harmonic Oscillator in Schrodinger and Heisenberg picture.	3
		Book 1- Relevant sections of Chapter 3 &4	
2	**Theory Of Angular Momentum**		**12**
	1	Orbital Angular Momentum-General Formalism of Angular Momentum	3
	2	Matrix Representation of Angular Momentum- Spin Angular Momentum-	3
	3	Eigen Functions of Orbital Angular Momentum	3
	4	Addition of angular momenta- General Formalism-Clebsch-Gordon Coefficients.	3
		Book 2- Sections 5.1 - 5.7, 7.3	
3	**Symmetry And Conservation Laws**		**12**
	1	Identical Particles- Two particle Systems	3
	2	Symmetries and Conservation Laws-Introduction- Transformations in Space	3
	3	The Translation Operator-Conservation Laws	3

	4	Parity-Parity in One and three Dimensions-Parity Selection Rules-Rotational Symmetry-Degeneracy- Translations in Time	3
		Book 2-Section 5.1, Book 3 - Sections 6.1 to 6.6, 6.8	
4	**Approximation Methods for Stationary States**		**12**
	1	Time Independent Perturbation Theory-Non degenerate and degenerate cases	3
	2	Fine structure of Hydrogen- Relativistic Correction	3
	3	Variational Principle-Theory- ground state energy of He atom	3
	4	WKB Approximation- Classical region- Tunneling- Connection Formulae	3
		Book 3- Sections 7.1-7.3, 8.1-8.2, 9.1-9.3	
5	**Teacher Specific Module**		**12**
	Directions:		
	1. The EPR Paradox 2. The Copenhagen Interpretation 3. The Ensemble Interpretation 4. Explanations of EPR Paradox 5. The Hidden Variable Theories		

Essential Readings:

1. Quantum Mechanics, V. K. Thankappan, 2nd Edn. New Age International (P) Limited, Publishers, Reprint 2003.
2. Quantum Mechanics- Concepts and Applications, Nouredine Zettili, 3rd edn, 2009.
3. Introduction to Quantum Mechanics (3rd Edition), David J Griffiths, Dasrrell F Schroeter, 2018.

Suggested Readings:

1. Principles of quantum Mechanics- R. Sankar, 2nd Edn. , 2014.

2. Modern Quantum Mechanics- J. J. Sakurai and Jim Napolitano, Pearson Education, 2009.

Assessment Rubrics:

Evaluation Type		Marks
ESE		**70**
CCA		**30**
a)	*Test Paper	10
b)	**Assignment/ Book- Article Review	10
c)	Seminar/ Viva -Voce	10
Total		**100**

*Best out of two test papers

** or any other activities like quiz, open book exam, group activity

KU7DSCPHY404: Electrodynamics II

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VII	DSC	400	KU7DSCPHY404	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture+ Tutorial	Practical/ Internship	CE	ESE	Total	
3	2	35	65	100	2

Course Description:

This course includes the intricate theories and mathematical formulations of electromagnetic fields and waves. The course covers potentials, wave propagation, and radiation theory. Students will explore advanced topics like relativistic electrodynamics applying these concepts to modern research problems.

Course Prerequisite: Solid foundation in classical electromagnetism and mathematical physics.

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understanding Electrostatic Boundary Problems, Gain proficiency in solving Poisson's and Laplace's equations, and comprehend the uniqueness theorems and charge distributions on conductors.	*U*

2	Apply the technique of image charges to solve electrostatic problems involving conductors, including planes, spheres, ellipsoids, and cylinders.	*A*
3	Learn the formulation of scalar and vector potentials, gauge transformations, retarded potentials, Jefimenko's equations, and the radiation emitted by electric and magnetic dipoles	*U, A*
4	Develop an understanding of Lorentz transformations, the geometry of spacetime, covariant forms of electromagnetic equations, and the electromagnetic field tensor.	*An*
5	Analytical and Problem-Solving Skills: Enhance analytical skills and problem-solving abilities in classical electromagnetism through a comprehensive study of advanced concepts and mathematical techniques.	*An, E*

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	2	1	1	1	1	1
CO 2	3	3	2	1	1	0	1
CO 3	2	2	3	2	0	1	0
CO 4	2	2	2	3	0	1	1
CO 5	2	2	2	2	3	1	1

****Correlation level 0-None, 1-Slight, 2-Medium, 3-High***

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**Electrostatic Boundary - Value Problems**		**12**
	1	Poisson's and Laplace's equations	3
	2	The potential at the centre of a sphere in charge free region-Absence of an absolute Maximum or a Minimum	3
	3	Uniqueness theorem with Laplace's equation- Uniqueness theorem for solutions of Poisson's equation- Unique distribution of charge on a conductor	3
	4	Charge distribution on a conducting sphere in an otherwise uniform electric field- Solution of Laplace's equation	3
		Chapter 6 all sections of Book 1	
2	**Method of Images**		**8**
	1	Basic theory- A charge q near a large charged conducting plane	2
	2	A point charge placed in a front of a conducting sphere	2
	3	Charged ellipsoidal conductor-	2
	4	A line charge in front of a conducting cylinder.	2
		Chapter 7 all sections of Book 1	
3	**Radiation**		**13**
	1	Scalar and vector potential - Gauge Transformations - Coulomb Gauge and Lorenz Gauge	3
	2	Retarded Potentials - Jefimenko's Equations - Liénard – Wiechert Potentials	3
	3	Electric dipole radiation - Magnetic dipole radiation - Power Radiated by a Point Charge: Larmor formula	4

	4	Radiation reaction: The Abraham-Lorentz formula.	3
		Sections 10.1.1 to 10.3.1, 11.1.2, 11.1.3, 11.2.1 and 11.2.2 of Book 2	
4	**Relativistic electrodynamics**		**12**
	1	Basic concepts of Lorentz Transformation – Geometry of space time	3
	2	Lorentz transformation as an orthogonal transformation	3
	3	Covariant form of electromagnetic equations like continuity equation, Maxwell's equations etc	3
	4	The electromagnetic field tensor – Transformation law for the electromagnetic field.	3
		Sections 22.2 to 22.6 of Book 3	
5	**Practical Module**		**30**
	*Directions: **AT least 6** experiments from the list and 2 experiments /activities designed by the course faculty*		
	1. Series Voltage regulator with feedback using IC741. (Regulation characteristic with load for 2. different input voltages) 3. Two stage R.C Coupled transistor/FET amplifier 4. Negative feedback amplifier (I/O resistance with and with outfeed back) 5. Wien Bridge oscillator using OPAMP 6. Saw tooth Generator using transistors (for different frequencies) 7. Schmitt Trigger using OPAMP. (Trace Hysteresis curve, Determine LTP and UTP) 8. OPAMP – analogue integration and differentiation 9. Astable and monostable multivibrator using OPAMP 10. Voltage controlled oscillator using 555 IC 11. Binary Adders – HA and FA using NAND gates 12. D/A converter – a) Binary weighted resistors b) R-2R Ladder (Four bit or more. Verify output for different digital inputs)		

	13. Study of Flip – Flops. RS & JK using IC 7400 (Verify Truth tables)	

Essential Readings:

1. Classical Electromagnetism by H C Verma Bharati Bhawan Publishers and distributors, 2022.
2. Introduction to Electrodynamics, Third edition, David J Griffiths, Prentice Hall India. 2013.
3. Foundations of electromagnetic Theory, John R.Reitz, Frederic J Milford, Robert W Christy,Third Edition, Narosa Publishing House. 1997.

Suggested Readings:

1. Schaum's outlines Electromagnetics by Joseph A Edminister McGraw Hill

Assessment Rubrics:

Evaluation Type			**Marks**	**Evaluation Type**			**Marks**	**Total**
Lecture			**75**	**Practical**			**25**	**100**
a)	**ESE**		**50**	a)	**ESE**		**15**	
b)	**CCA**		**25**	b)	**CCA**		**10**	
	i	*Test Paper	10		i	Punctuality	3	
	ii	**Assignment/ Book-Article review	10		ii	Skill	4	
	iii	Seminar/ Viva-Voce	5		iii	Record	3	

*Best out of two test papers

** or any other activities like quiz, open book exam, group activity

KU7DSCPHY405: Statistical Mechanics

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VII	DSC	400	KU7DSCPHY405	4	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture+ Tutorial	Practical	CE	ESE	Total	
4	0	30	70	100	2

Course Description:

This course aims an in-depth study of the topic Statistical Mechanics with all its flavour using the concepts of different types of ensembles. The study of quantum statistical mechanics helps the students in understanding the microscopic details by studying the macroscopic properties.

Course Prerequisite: Basic Mathematical methods

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the concepts of microstate, macrostate, ensemble, phase space, thermodynamic probability, and partition function.	*U*
2	Understand the difference between classical statistics and Quantum statistics.	*U, An*
3	Understand the concepts of thermodynamical properties of Bosons, BEC, thermodynamic properties of Fermions	*U, A*

4	Understand the phenomena of phase transitions	*U*

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	2	1	1	1	1	0
CO 2	3	3	1	0	0	1	0
CO 3	2	3	3	0	1	0	1
CO 4	2	2	2	3	1	0	1

Correlation level 0-None, 1-Slight, 2-Medium, 3-High

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**Statistical Basis of Thermodynamics & Elements of Ensemble Theory**		**8**
	1	The macroscopic and microscopic states. - Boltzmann relation between entropy and microstates - Connection between statistics and thermodynamics	2
	2	Classical ideal gas - Gibbs paradox -The correct enumeration of microstates	2
	3	Phase space- Liouville's theorem and its significance	2

	4	The microcanonical ensemble— Examples of calculation of microstates (Classical ideal gas and Simple Harmonic oscillator), conceptual problems.	2
		Sections 1.1 to 1.6, Sections 2.1 to 2.4 of Book 1	
2	**Canonical and Grand canonical ensembles**		**14**
	1	Equilibrium between a system and reservoir, A system in the canonical ensemble -method of most probable values- Physical significance of statistical quantities in the canonical ensemble	3
	2	Partition function for non-degenerate and degenerate systems-Density of states-The classical systems- Energy fluctuation in canonical ensemble; correspondence with the microcanonical ensemble, Equipartition theorem and virial theorem. A system of harmonic Oscillators.	4
	3	Equilibrium between a system and a particle–energy reservoir, A system in Grand canonical ensemble-Physical Significance of statistical quantities- Examples in grand canonical ensemble, Classical ideal gas, a system of independent localized particles (Harmonic Oscillators)	4
	4	Density and energy fluctuations in grand canonical ensemble correspondence with other ensembles	3
		Sections 3.1 to 3.8 , 4.1 to 4.5 of Book 1	
3	**Theory of Simple gases and Ideal Bose and Fermi Systems**		**15**
	1	An ideal gas in quantum mechanical micro canonical ensemble	3
	2	An ideal gas in other quantum mechanical ensembles- statistics of occupation numbers.	4
	3	Thermodynamic behaviour of an ideal Bose gas, Bose-Einstein condensation - Thermodynamics of the blackbody radiation	4
	4	Ideal Fermi Systems**-** Thermodynamic behaviour of an ideal Fermi gas - Fermi temperature and Fermi energy- Magnetic behaviour of ideal Fermi gas , Pauli paramagnetism- Landau diamagnetism	4
		Sections 6.1 to 6.3 , 7.1 and 7.3 , 8.1 to 8.3 of Book 1	

4	**Continuous Phase Transitions**		**11**
	1	Introduction, Ising model	2
	2	Mean Field Theory, Order parameter	3
	3	Symmetry breaking Field	3
	4	Critical Exponents.	3
		Sections 12.1 to 12.6 of Book 2	
5	**Teacher Specific Module**		**12**
	Directions		
	Problems related to the topic		

Essential Readings:

1. R K Pathria, Paul D. Beale - Statistical Mechanics, Fourth Edition (2022, Academic Press).
2. Roger Bowley, Mariana Sánchez - Introductory Statistical Mechanics, Second Edition (2000, Oxford University Press, USA).

Suggested Readings:

1. Kerson Huang, Statistical Mechanics, Second edition, John Wiley and Sons (1987).
2. Mehran Kardar - Statistical Physics of Particles (2007, Cambridge University Press)
3. Silvio RA Salinas - Introduction to Statistical Physics (2010, Springer)
4. Ivo Sachs, Siddhartha Sen, James Sexton - Elements of statistical mechanics (2006, Cambridge University Press)
5. M. Glazer, J. S. Wark - Statistical mechanics- a survival guide (2001, Oxford University Press, USA)
6. D. ter Haar - Elements of statistical mechanics (1995, Butterworth-Heinemann)
7. Daniel C. Mattis - Statistical mechanics made simple- a guide for students and researchers (2003, World Scientific)
8. David Chandler - Introduction to modern statistical mechanics (1987, Oxford University Press)
9. Giuseppe Morandi - Statistical mechanics- An intermediate course (1996, World Scientific Publishing Company)

Assessment Rubrics:

Evaluation Type		Marks
ESE		**70**
CCA		**30**
a)	*Test Paper	10
b)	**Assignment/ Book- Article Review	10
c)	Seminar/ Viva -Voce	10
Total		**100**

*Best out of two test papers

** or any other activities like quiz, open book exam, group activity

SEMESTER VIII

KU8DSCPHY405 : Advanced Electronics

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VIII	DSC	400	KU8DSCPHY405	4	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture + Tutorial	Practical	CE	ESE	Total	
4	0	30	70	100	2

Course Description:

This course explores the theoretical foundation of Op-Amp and discuss the linear and non -linear circuits of Op-Amp in various application. This course also covers advanced digital electronics components like flip-flops, registers, counters etc. and discuss the digital signal and data processing, transmission, and control.

Course Prerequisite: Graduate level knowledge of Analog and Digital Electronics Physics

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the solid theoretical foundation in Op-Amp principles, frequency response and application and also enhance problem solving skills specific to analogue circuit.	*U , A*
2	Design and analyse advanced circuits such as filters, oscillators and comparators using Op- amp	*A, An*

3	Understand the operation and characteristics of various types of Flip – flops, registers and counters. Explore the real-world application of flip-flops, shift registers and counters.	*U, A*
4	Analyse and design the circuits for digital electronics. Understand the signal data conversion, processing, transmission and control.	*U, An*

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	2	2	2	2	3	1	0
CO 2	3	3	2	2	3	0	0
CO 3	2	1	3	2	2	0	1
CO 4	1	1	1	3	3	1	1

Correlation level 0-None, 1-Slight, 2-Medium, 3-High

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	**UNIT**	**DESCRIPTION**	**HOURS**
	Operational Amplifiers and Application		**16**

1	1	**Differential Amplifiers**: Differential Amplifier, DC Analysis and AC Analysis of Differential Amplifier	2
	2	**The Operational Amplifier**: Block Diagram Representation of a Typical Op-Amp, Schematic Symbol, and Integrated Circuits, **Ideal Op-Amp:** Equivalent Circuit of an Op-Amp, Ideal Voltage Transfer Curve and Open - loop Op-Amp Configurations.	3
	3	**Op-Amp Negative Feedback**: Block Diagram Representation of Feedback configurations, Voltage Series Feedback Amplifier, Voltage Shunt Feedback Amplifier, Differential Amplifier (with one Op-Amp)	3
	4	**Practical Op-Amp**: Input Offset Voltage (Compensating Network design *not required*), Input Bias Current, Input Offset Current, Total Offset Voltage, Common Mode Configuration and Common Mode Rejection Ratio. **Frequency Response of Op-Amp**: Frequency Response, Compensating Networks, High-frequency Op-Amp Equivalent circuit, Open-Loop Voltage Gain as a Function of Frequency, Closed - Loop Frequency Response- Slew Rate	4
	5	**Op-Amp General Linear Application**: Summing, Scaling and Averaging Amplifiers, Voltage to Current Converter with Floating Load and Grounding Load (*Basic idea),* Current to Voltage Converter- DAC using Current to Voltage Converter, Integrator and Differentiator.	4
	Book 4: 15.1 – 15.3 **Book 1: Sections 2.2 – 2.3, 2.5 – 2.6, 3.3 – 3.5.1, 4.2 – 4.5, 4.11, 5.2 – 5.8, 5.10, 6.5, 6.8.1, 6.9-6.10, 6.12-6.13**		
	Op - Amp Active Filters, Oscillators and Comparators		**10**

2	1	**Active Filters**: Introduction, Active Filters, First and Second Order Low Pass Butterworth Filters	4
	2	**Oscillators**: Oscillators, Phase Shift Oscillator, Wein Bridge Oscillator, Square Wave Generator, Triangular Wave Generator and Sawtooth Wave Generator.	3
	3	**Comparators**: Introduction, Basic Comparator, Zero Crossing Detector, Schmitt Trigger, Comparator Characteristics, Voltage Limiters.	3
	Book 1: Sections 7.2 –7.6, 7.11 – 7.17, 8.1 – 8.5, 8.7		
	Digital Electronics – Flip-Flops, Shift Register And Counters		**12**
3	1	**Flip-Flops**: Introduction, Latches and Flip-Flops, Asynchronous Inputs, Flip-Flop Operating Characteristics, Clock Skew and Time Race, Race Around Condition, Master Slave Flip-Flop, Flip-Flop Excitation tables, Applications of flip-flops.	4
	2	**Shift Registers**: Introduction, Buffer Register, Controlled Buffer Register, Data Transmission in Shift Registers, Serial in – Serial out, and Serial in - Parallel out, and Parallel in – Serial out, Parallel in – Parallel out Shift Registers and Application of Shift Registers.	4
	3	**Counters:** Introduction, Asynchronous Counters (Ripple Counters), Design of Asynchronous Counters, Synchronous Counters – Design of Synchronous Counters – 3-bit up-down, 3-bit up, 3-bit down and Modulo -10 up/down Counters.	4
	Book 2: Sections – 10.1 – 10.10,10.12, 11.1 – 11.8, 11.12, 12.1 – 12.3, 12.5 (12.5.1 to 12.5.5)		
	Digital Electronics – Signal and Data Conversion, Processing, Transmission and Control		**10**
4	1	**Signal Conversion and Processing:** Analog to Digital Conversion (ADC), Methods of Analog to Digital Conversion – Methods of	3

		Digital to Analog Conversion (DAC) – Binary-Weighted-Input and R/2R Ladder DAC, Digital Signal Processing (DSP)	
	2	**Data Transmission**: Methods and Modes of Data Transmission, Modulation of Analog Signal with Digital Data, Modulation of Digital Signal with Analog Data	3
	3	**Data Processing and Control**: Computer System, Practical Computer System Consideration, The Processor – Basic Operation, Addressing Modes, Special Operations.	4
	Book 3: Sections – 12.1 – 12.5, 13.2 – 13.4, 14.1 – 14.5		
5	**Teacher Specific Module**		**12**
	Directions: Advanced application of Electronics		

Essential Readings:

1. Op-Amps and Linear Integrated Circuits – 4th Edition, Ramakant A Gayakwad (PHI), 2015.
2. Fundamentals of Digital Circuits, 4th Edition, A Anand Kumar (PHI), 2016.
3. Digital Fundamentals, 11th Edition, Thomas L Floyd (Pearson), 2017.
4. Electronics Principles, 9th Edition, Albert Malvino, David J Bates and Patrick E Hoppe (Mc Graw Hill) , 2021.

Suggested Readings:

1. Electronic Devices and circuit theory - Robert L Boylestad & Louis Nashelsky (Pearson Eduaction), 2015.
2. Integrated Circuits , Millman (Mc Graw Hill)
3. Electronic Devices and Circuits David A Bell, 2009.
4. Electronic Fundametals and Applications – John D Ryder(PHI)
5. Digital Principles and Applications - D P Leach and A P Malvino (TMH), 2014.
6. Modern Digital Electronics – R P Jain (Mc Graw Hill)
7. Digital Principles and Applications – Donald P Leach, Albert Paul Malvino and Goutam Saha (TMH)

Assessment Rubrics:

Evaluation Type		Marks
ESE		**70**
CCA		**30**
a)	*Test Paper	10
b)	**Assignment/ Book- Article Review	10
c)	Seminar/ Viva -Voce	10
Total		**100**

*Best out of two test papers

** or any other activities like quiz, open book exam, group activity

KU8DSCPHY406 : Condensed Matter Physics

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VIII	DSC	400	KU8DSCPHY 406	4	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture+ Tutorial	Practical	CE	ESE	Total	
4	0	30	70	100	2

Course Description:

Condensed matter physics use the well-established laws of microscopic physics to predict the collective and structural properties of matter. It is a science geared to technological development and is one of the most important areas of research in the recent times.

Course Prerequisite: Solid State Physics

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	To make students familiar with structures having regular and irregular arrangement of atoms , their bonding, lattice dynamics etc.	*U, An*
2	To understand electron gases hence analyse the properties of metals	*U*
3	To apply statistical mechanics and quantum mechanics to study the electric and magnetic properties of matter	*A*
4	To understand the property of superconductivity.	*U, A*

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	2	1	1	3	2	2	1
CO 2	1	2	0	2	2	1	0
CO 3	1	1	3	3	2	2	0
CO 4	0	1	1	3	2	1	2

Correlation level 0-None, 1-Slight, 2-Medium, 3-High

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**Lattice Dynamics**		**9**
	1	Bragg law - Scattered wave amplitude - Brillouin Zones	2
	2	Fourier analysis of the basis. Vibrations of crystals with monatomic and diatomic basis	3
	3	Quantization of elastic waves -phonon momentum -	2
	4	Phonon heat capacity	2
		Chapters 2, 4 & 5 of Book 1	
2	**Quantum Behaviour of Electron Gases and Conductivity in Solids**:		**15**
	1	Energy levels in 1D - Effect of temperature on Fermi - Dirac distribution - Free electron gas in three dimension - Heat capacity of electron gas - Electrical conductivity and Ohm's law	4
	2	Hall effect -Thermal conductivity of metals	3
	3	Nearly free-electron model – Bloch functions - Kronig-Penny model - Wave equation of electron in a periodic potential.	4

	4	Band gap - equations of motion - Intrinsic carrier concentration - Impurity conductivity - Calculation of energy bands(Wigner Seitz method)	4
		Chapters 6, 7, 8 & 9 of Book 1	
3	**Magnetic properties of materials**		**12**
	1	Langevin classical theory of diamagnetism, Langevin classical theory of paramagnetism,	3
	2	Fundamentals of quantum theory of paramagnetism, Ferromagnetism	3
	3	The Weiss molecular field, Temperature dependence of spontaneous magnetisation	3
	4	Ferromagnetic domains.	3
		Chapters 16 of Book 2	
4	**Superconductivity**		**12**
	1	Introduction, Sources of Superconductivity	3
	2	Response of Magnetic Field, The Meissner Effect, Thermodynamics of Superconducting Transform, Origin of Energy Gap, Isotope Effect	3
	3	London Equations, London Penetration Depth, Coherence length	3
	4	Elements of BCS Theory, Flux Quantization, Normal Tunneling and Josephson Effect, High Temperature Superconductivity.	3
		Chapters 17 of Book 2	
5	**Teacher Specific Module**		**12**
	Directions		
	Problems related to the content		

Essential Readings:

1. C. Kittel-Introduction to Solid State Physics-VIII Edition –John Wiley & Sons., 2012.
2. M. A. Wahab –Solid State Physics-Structure and Properties of Materials-Narosa Pub.1999.

Suggested Readings:

1. A. J. Dekker, Solid State Physics, Macmillan
2. N. W. Ashcroft and N. D. Mermin, Solid State Physics, Cenage I Edition(2003).
3. Azaroff. V, Introduction to Solids, TMH
4. Omar Ali, Elementary Solid State Physics, Addison Wesley.
5. J. S. Blakemore, Solid State Physics, Cambridge University Press.
6. S. O. Pillai, Solid State Physics, New Age International Publishers.
7. H. C. Gupta, Solid State Physics, Vikas Publishing
8. V.S Muraleedharan & A Subramania, Nano Science & Technology, Ane Books Pvt Ltd,2009.
9. Bharat Bhushan(Ed), Hand book of Nano Technology, Springer 2003
10. Gouzhong Cao, Nano structure and Nano materials: Synthesis, Properties and
11. applications, Imperial college press, 2004.
12. NPTEL, Lectures on Solid State Physics by Nirmal Ganguly (NOC: Solid State Physics) ISER Bhopal. https://archive.nptel.ac.in

Assessment Rubrics:

Evaluation Type		Marks
ESE		**70**
CCA		**30**
a)	*Test Paper	10
b)	**Assignment/ Book- Article Review	10
c)	Seminar/ Viva -Voce	10
Total		**100**

*Best out of two test papers

** or any other activities like quiz, open book exam, group activity

KU8DSCPHY407: Nuclear and Particle Physics

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VIII	DSC	400	KU8DSCPHY407	4	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture+ Tutorial	Practical	CE	ESE	Total	
4	0	30	70	100	2

Course Description:

The course aims to develop an understanding of Properties of nucleus, nature of nuclear force, potentials, and nuclear models with the underlying quantum mechanical principles. Also, the students can get the idea of different types of nuclear radiation and their properties. The course provides the details of different elementary particles and its properties. In short, the course provides a good platform to carry forward the studies to higher levels.

Course Prerequisite: Basics about atoms and molecules

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the basic properties of the nuclear force. Analyse the nucleon-nucleon scattering and its underlying principles.	*U, An*

2	Analyse the different nuclear models and nuclear reactions.	*An*
3	Understand different nuclear decays and analyse the decay processes with theory. Analyse nuclear fission and its applications.	*U, An*
4	Review the conservation laws governing interactions involving elementary particles and discuss its Internal structure	*R, A*

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	1	1	1	1	2	2
CO 2	1	3	1	0	1	2	2
CO 3	0	1	3	2	0	2	1
CO 4	1	0	2	3	2	2	0

Correlation level 0-None, 1-Slight, 2-Medium, 3-High

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**Properties of Nucleus and Nuclear force**		**13**
	1	Nuclear properties: Nuclear Radius-Charge distribution and matter distribution; Nuclear binding energy- semi empirical mass formula, stability of nucleus; spin, parity, Magnetic and electric moments. Nuclear two body problem- The deuteron- simple theory and properties;	7
	2	Nucleon-nucleon scattering, partial wave analysis of n-p scattering, phase shift, singlet and triplet state, scattering length and effective range, p-p and n-n interaction(Qualitative ideas) Properties of nuclear force-Attractive central potential, repulsive core, spin dependence, tensor potential, Charge symmetry and charge independence, Exchange force model	6
		Sections 3.1, 3.3, 3.4, 3.5, 4.1, 4.2, 4.3, 4.4, 4.5- Book 1	
2	**Nuclear Models and reactions**		**13**
	1	Nuclear models:- The Shell Model, shell model potentials, spin-orbit potential, magnetic dipole moments, electric quadrupole moments, valance nucleons, Collective structure- nuclear vibrations and nuclear rotations.	7
	2	Nuclear reactions: Types of reactions and conservation laws, energetics, Scattering and reaction cross Sections, compound nuclear reactions, direct reactions, resonant reaction.	6
		Sections 5.1, 5.2, 11.1, 11.2, 11.4, 11.8, 11.10, 11.11, 11.12- Book 1	
3	**Nuclear decays and Controlled Fission**		**12**

	1	Nuclear decays: Types of decays, Basic alpha decay processes, Theory of alpha emission, beta decay, simple theory of beta decay, Kurie plot, angular momentum and parity selection rules, gamma decay, multipole moments and selection rules, Internal conversion.	7
	2	Nuclear fission, Characteristics of fission, energy released in fission, controlled fission reactions, fission reactors.	5
		Sections: 6.5, 8.2, 8.4, 9.1, 9.2, 9.3, 10.1, 10.2, 10.4, 10.6 13.1, 13.2, 13.3, 13.5, 13.6- Book 1	
4	**Elementary Particle Physics**		**10**
	1	Four basic forces - Gravitational, Electromagnetic, Weak and Strong - Relative strengths, Classification of particles, Yukawa's theory, Conservation of energy and masses, Electric charges, Conservation of linear and angular momentum, Baryon and lepton numbers, Conservation of strangeness, Conservation of isospin and its components, Conservation of parity, Charge conjugation, CP violation, time reversal and CPT theorem.	5
	2	The Sakata model, SU (3), The eight fold way, Gell-Mann and Okubo mass formula, Quarks and quark model, Confined quarks, Experimental evidence, Coloured quarks.	5
		Chapter 6, 7, 9 Book 2	
5	**Teacher specific Module**		**12**
	Directions		
	1	Nuclear fusion, Nuclear astrophysics	

Essential Readings:

1. Introductory Nuclear Physics (3rd Edition), Kenneth S. Krane, Wiley (1987).
2. The particle hunters (2nd Revised Edition), Y. Neeman and Y. Kirsh, Cambridge University Press (1996)

Suggested Readings:

1. Introduction to Nuclear Physics (1st Edition), Harald A. Enge, Addison Wesley (1996).
2. An Introduction to nuclear Physics (2nd Edition), W. A. Cottingham, D. A. Greenwood
3. Concepts of Nuclear Physics, B. L. Cohen, McGraw-Hill Inc., US (1971).
4. Nuclear Physics: Theory and Experiment, R. R. Roy and B.P. Nigam, Newagepublishers (1996).
5. Theoretical Nuclear Physics, J. M. Blatt and V. F. Weisskopf, Springer-Verlag New York (1979).
6. An Introduction to Nuclear Physics (2nd Edition), S. B. Patel, New Age International (2011).
7. Nuclei and Particles, E. Segre, Benjamin (1967).

Assessment Rubrics:

Evaluation Type		Marks
ESE		**70**
CCA		**30**
a)	*Test Paper	10
b)	**Assignment/ Book- Article Review	10
c)	Seminar/ Viva -Voce	10
Total		**100**

*Best out of two test papers

** or any other activities like quiz, open book exam, group activity

DISCIPLINE SPECIFIC ELECTIVES

KU8DSEPHY401:Research Methodology in Physics

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VIII	DSE	400	KU8DSEPHY401	4	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture+ Tutorial	Practical	CE	ESE	Total	
4	0	30	70	100	2

Course Description:

To address research questions or test hypotheses, quantitative or qualitative data must be gathered, analysed, and interpreted using a systematic, scientific procedure known as research methodology. A research technique helps researchers stay on track by restricting the scope of the study, much like a plan for carrying out research. On completing the course, a student will be able to appreciate the scientific research methodology. To develop the capability of the students to find research problems, to conduct research and to report the findings in an ethical manner are the main concerns of the course.

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Appreciate the importance of research activities in various fields of science	*R*
2	Understand the various components of scientific research	*U*

3	Identify various research problems in the field of physics	*An*
4	Undertake research activities and report the findings in an ethical manner	*A*

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	2	1	1	0	1	1	3
CO 2	2	1	0	1	1	1	3
CO 3	2	1	3	2	2	2	3
CO 4	2	2	3	3	3	2	3

Correlation level 0-None, 1-Slight, 2-Medium, 3-High

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**Scientific Research**		**10**
	1	Definitions, Meaning and characteristics of research	3
	2	Types of Research and importance of research activities	2
	3	Problems in research and research in academic fields - Planning and designing research activity	3

	4	Criteria for good research and monitoring research activities	2
		Book 1: Section 1.1-1.5, 1.8, 3.4,3.5, 3.13	
2	**Scientific Methodology**		**12**
	1	Definition, characteristics, rules and principles of scientific method -	3
	2	Hypothesis- Definition, types of hypotheses, sources of hypothesis and testing of hypothesis	3
	3	Experimental design – principles, characteristics and types of experimental design	3
	4	Classification of experiments and requirements of a good experiment - Interpretation and generalization of research findings	3
		Book 1: Section 4.2-4.4, 4.6-4.8	
3	**Scientific Writing**		**13**
	1	Importance and characteristics of scientific writing - Literature review, needs, planning and locating relevant literature, academic and general search engines	4
	2	writing a literature review - Journals, scientific paper, review paper, short communication and rapid communication	3
	3	Journal impact factor, citation index, h-index, g-index, hg- index, i10 index	2
	4	Components of a scientific paper- title, abstract, key words, introduction, methodology, results and discussion, conclusion, references	4
		Book 1: Section 6.2, 6.3-6.9, 7.1	
4	**Research Ethics**		**13**
	1	Importance of research ethics, values and principles of ethics - Intellectual property rights,	3

	2	Examples for scientific misconduct, plagiarism, different forms of plagiarism and methods to avoid plagiarism, tools for plagiarism checking	4
	3	Costs of scientific misconduct and dealing with scientific misconduct	3
	4	Research ethics committees and functions - Ethical issues in publication	3
		Book 1: 9.-9.5, 9.7-9.9, 10.5	
5	**Teacher Specific Module**		**12**
	Directions		
	Familiarisation of Research Journals		

Essential Readings:

1. K. Prathapan, "*Research Methodology for Scientific Research*" (Second Edition), iK International Publishers, New Delhi, (2023)

Suggested Readings:

1. C. George Thomas, "*Research Methodology and Scientific Writing*" Springer (2021).
2. Suresh Chandra and Mohit Kumar Sharma, "*Research Methodology*", Narosa Publishing House PVT. Ltd, New Delhi, (2013).
3. C. R. Kothari, "*Research Methodology- Methods and Technique*", New Age International (2004)
4. Santhosh Kumar Yadav, "Research and Publication Ethics". Anne Books PVT. Ltd. New Delhi (2022)
5. Dilip Dutta "*Good Practices and Ethics in Research and Publication*", Anne Books PVT. Ltd, New Delhi (2021).
6. Upendra Prathap Singh "*Research and Publication Ethics*", S Chand Publishing (2023).
7. Pankaj Mittal and Sistla Rama Devi Pani "*Reimagining Indian Universities*" Association of Indian Universities (2020)

8. Yogesh Kumar Singh, "*Fundamentals of Research Methodology and Statistics*", New Age International (2006)

Assessment Rubrics:

Evaluation Type		Marks
ESE		**70**
CCA		**30**
a)	*Test Paper	10
b)	**Assignment/ Book- Article Review	10
c)	Seminar/ Viva -Voce	10
Total		**100**

*Best out of two test papers

** or any other activities like quiz, open book exam, group activity

KU8DSEPHY402 : Nonlinear Optics

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VIII	DSE	400	KU8DSEPHY402	4	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture+Tutorial	Practical	CE	ESE	Total	
4	0	30	70	100	2

Course Description:

This course introduces the field of nonlinear optics, covering basic concepts and descriptions of nonlinear optical processes, focuses on the wave-equation description of nonlinear optical interactions, including phase matching and various nonlinear processes. It also explores the intensity-dependent refractive index and various mechanisms contributing to nonlinear optical effects.

Course Prerequisite: Optics

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the fundamental principles and phenomena of nonlinear optics, involving nonlinear optical effects such as harmonic generation and optical solitons.	*U*

2	Analyse the interaction of intense light with matter and its applications.	*An*
3	Understand intensity dependent refractive index	*U*
4	Analyse stimulated Raman and Rayleigh scattering	*An*

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	2	1	2	1	0	0
CO 2	2	3	2	3	0	1	0
CO 3	1	2	3	2	1	1	0
CO 4	2	3	1	2	1	0	1

Correlation level 0-None, 1-Slight, 2-Medium, 3-High

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**The Nonlinear Optical Susceptibility**		**10**

	1	Introduction to Nonlinear optics- Descriptions of Nonlinear optical Processes	3
	2	Formal Definition of Nonlinear Susceptibility-Nonlinear Susceptibility of a classical Anharmonic Oscillator- Properties of Nonlinear Susceptibility	4
	3	Time Domain description of Optical Nonlinearities – Kramers-Kronig Relations in Linear and Nonlinear optics.	3
		Book 1- Chapter 1	
2	**Wave-Equation Description of Nonlinear Optical Interactions**		**12**
	1	The wave equation for Nonlinear optical Media- The Coupled Wave equation for Sum-Frequency generation	3
	2	Phase Matching-Quasi Phase Matching-The Manley-Rowe Relations	3
	3	Sum-Frequency Generation-Second Harmonic Generation-Difference- Frequency Generation and Parametric Amplification	3
	4	Optical Parametric Oscillators- Nonlinear Optical Interactions with Focussed Gaussian Beams-Nonlinear optics at an interface.	3
		Book 1-Chapter 2	
3	**The Intensity-Dependent Refractive Index**		**12**
	1	Descriptions of Intensity Dependent Refractive Index	3
	2	Tensor Nature of Third Order Susceptibility	3
	3	Nonresonant Electronic Nonlinearities-Nonlinearities Due to Molecular Orientation	3
	4	Thermal Nonlinear Optical Effects-Semiconductor Nonlinearities.	3
		Book 1-Chapter 4	

4	**Stimulated Raman Scattering and Stimulated Rayleigh-Wing Scattering**		**14**
	1	The spontaneous Raman Effect-	3
	2	Spontaneous versus Stimulated Raman Scattering-Stimulated Raman Scattering Described by the Nonlinear Polarization	4
	3	Stokes-Anti-Stokes Coupling in Stimulated Raman Scattering	3
	4	Coherent Anti-Stokes Raman Scattering-Stimulated Rayleigh Wing Scattering.	4
		Book 1- Chapter 10	
5	**Teacher Specific Module**		**12**
	Directions:		
	Can be designed by course faculty		

Essential Readings:

1. Nonlinear optics-Robert W Boyd(3^{rd} Edition), 2008.
2. Nonlinear optics- Basic Concepts- D L Mills, 2 edn, 1998.
3. Nonlinear Optics- P G Harper and B S Wherrett (Academic Press, London), 1977.

Suggested Readings:

1. Fundamentals of Nonlinear Optics -Peter E Powers, Joseph W Haus 2nd Edn.
2. Nonlinear Optics Principles and Applications-Karsten 1st Edn

Assessment Rubrics:

Evaluation Type		Marks
ESE		**70**
CCA		**30**
a)	*Test Paper	10
b)	**Assignment/ Book- Article Review	10
c)	Seminar/ Viva -Voce	10
Total		**100**

*Best out of two test papers

** or any other activities like quiz, open book exam, group activity

KU8DSEPHY403: Numerical Techniques and Probability Theory

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VIII	DSE	400	KU8DSEPHY403	4	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture+ Tutorial	Practical	CE	ESE	Total	
4	0	30	70	100	2

Course Description:

This course provides an in-depth study of numerical techniques for solving mathematical problems. and the fundamental concepts of probability. Topics include root-finding algorithms, numerical integration, differentiation, and the solution of ordinary differential equations, random variables, probability distributions, expected value, variance, and the central limit theorem, with applications to real-world scenarios

Course Prerequisite: Basic Mathematical methods

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Apply numerical techniques to solve algebraic and transcendental equations. Implement numerical differentiation and integration for engineering problems.	*U, A*

2	Utilize numerical methods for solving ordinary and partial differential equations. Analyze the accuracy and stability of numerical solutions.	*A, An*
3	Understand and apply basic probability principles and rules.Analyze random variables and their probability distributions.	*U, A, An*
4	Calculate expected values, variances, and higher moments. Apply the central limit theorem to solve practical problems in statistics	*E, A*

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**
CO 1	2	3	2	0	2	1	2
CO 2	3	3	2	2	2	0	2
CO 3	1	2	3	2	1	0	1
CO 4	1	1	0	3	2	0	2

Correlation level 0-None, 1-Slight, 2-Medium, 3-High

COURSE CONTENTS

Contents for Classroom Transaction:

M O D U	**U N**	**DESCRIPTION**	**HOURS**

L E	I T		
1	**Roots of transcendental equations**		**12**
	1	Bisection method, ordinary iteration method, condition for convergence, order of convergence, geometric significance	3
	2	Regula –Falsi method, order of convergence, geometric significance	3
	3	Newton- Raphson method, order of convergence, geometric significance.	3
	4	Differences**-** Forward and backward differences. Difference tables, Detection of errors, Difference of a polynomial	3
		Book 1	
2	**Interpolations and Curve Fitting**		**12**
	1	Linear interpolation, Polynomial interpolation	3
	2	Lagrange's interpolation, Newton's forward and backward interpolation formulae.	3
	3	Errors in interpolation	3
	4	Least squares curve fitting (linear and nonlinear)	3
		Book 1	
3	**Numerical Methods**		**12**
	1	Numerical Integration- Trapezoidal rule, Simpson's 1/3 and 3/8 rules. Gauss quadrature.	3
	2	Solution of First of Differential Equations- Euler's method, geometric significance	3
	3	Modified Euler's method, geometric significance ,	3

	4	Milne's method, Runge – Kutta method. (Second order and fourth order methods only)(Derivation not required)	3
		Book 1	
4	**Probability and Expected Value**		**12**
	1	Probability definition- Calculation of Probability- Addition theorem of Probability-Multiplication theorem – Baye's theorem	2
	2	Theoretical Distributions- Binomial distribution (Pascal's triangle, Properties of binomial distribution, constants of binomial distribution, fitting a binomial distribution)– Poisson Distribution (Role of the Poisson distribution, constants of Poisson distribution, fitting a Poisson distribution, Poisson distribution as an approximation of the binomial distribution	4
	3	Normal distribution (Graph of Normal distribution, Relation between Binomial, Poisson and Normal distributions, Properties of normal distribution, conditions for normality, constants of Normal distribution , area under the Normal curve	3
	4	CHI-Square test-$\chi 2$ Distribution-Probability Density Function of $\chi 2$ Distribution- Application of the $\chi 2$ distribution- χ 2 test of goodness of fit.	3
		Chapter 1,2 Book 3, Book 4	
5	**Teacher Specific Module**		**12**
	Directions:		
	Can be designed by course faculty		

Essential Readings:

1. Numerical Methoids – S.Arumugam,A. Thangapandi Isaac, A.Somasundaram-Scitech Publications Pvt .Ltd., 2^{nd} edn, 2015.
2. Text book of Probability and Theoretical Distribution-A.K Sharma, Discovery Publishing House, New delhi, 2005.
3. Fundamentals of Statistics- S.C Gupta-Himalaya Publishing House, 7^{th} edn., 2018.

Suggested Readings:

1. Introductory Methods of Numerical Analysis- S.S Sastry: (Prentice Hall of India)
2. Numerical Mathematical Analysis- J.B.Scarborough-Oxford and IBH, 6th Edition.
3. Numerical Analysis-Golden Maths Series- R.Gupta-Luxmi Publicatios Pvt.Ltd
4. Basic Statistics- A.L.Agarwal,New Age International Publishers

Assessment Rubrics:

Evaluation Type		Marks
ESE		**70**
CCA		**30**
a)	*Test Paper	10
b)	**Assignment/ Book- Article Review	10
c)	Seminar/ Viva -Voce	10
Total		**100**

*Best out of two test papers

** or any other activities like quiz, open book exam, group activity

KU8DSEPHY404: Experimental Techniques

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VIII	DSE	400	KU8DSEPHY404	4	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture+ Tutorial	Practical	CE	ESE	Total	
4	0	30	70	100	2

Course Description:

This course provides a comprehensive understanding of experimental techniques used in modern physics and materials science, focusing on vacuum systems, thin film deposition, accelerator-based methodologies, radiation detectors and X-ray diffraction techniques emphasising both theoretical principles and practical applications.

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Comprehensive understanding of various vacuum pump technologies, as well as vacuum gauges and accessories commonly used in experimental setups.	*U*
2	Development of practical skills in various thin film fabrication methods, along with the ability to measure film	*A, An*

	thickness using different methods and analyse thin film properties for diverse technological applications.	
3	Students will acquire knowledge about different types of particle accelerators, as well as ion sources and ion implantation techniques, enabling them to design and operate accelerator-based experiments.	*U, A*
4	Understanding the principles and operation of various nuclear radiation detectors, and associated electronics for signal processing and analysis.	*U*
5	Students will learn the theoretical principles of X-ray diffraction, and gain practical experience in operating diffractometers. Also developing skills in analysing diffraction data for various applications.	*A, An*

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	2	2	3	2	2	1	3
CO 2	3	3	2	1	2	1	3
CO 3	2	2	3	2	2	0	3
CO 4	2	1	2	3	2	0	3
CO 5	3	2	2	0	3	0	3

Correlation level 0-None, 1-Slight, 2-Medium, 3-High

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**Vacuum Techniques**		**12**
	1	Units and basic definitions, Roughing pumps - Oil sealed rotary vacuum pump and Sorption pump, High vacuum pumps – Turbo molecular pump, Diffusion pump, Oil vapour booster pump, Ion pumps - Sputter ion pump and Getter ion pump, Cryo pump	4
	2	Vacuum gauges - Pirani gauge, Thermocouple gauge, penning gauge (Cold cathode Ionization gauge) and Hot filament ionization gauge	3
	3	Vacuum accessories – Diaphragm, Gate valve, Butterfly valve, Baffle and isolation valves, magnetic valves, adjustable valves, air inlet valves,	3
	4	Traps - Liquid nitrogen trap, Sorption traps, and gaskets and O rings.	2
		Book 1, Sections 1.4, 1.6 – 1.8, 1.9.2.3 – 1.9.2.5, 1.10.1, 1.10.6, 1.10.3	
2	**Thin Film Techniques**		**10**
	1	Introduction, Fabrication of thin films, Thermal evaporation in vacuum – Resistive heating, Electron beam evaporation and laser evaporation techniques,	3
	2	Sputter deposition, Glow discharge	2
	3	Thickness measurement by quartz crystal monitor, optical interference method, electrical conductivity measurement, Thermo electric power,	3
	4	Interference filters - Multi layer optical filters, Technological Applications of thin films.	2

		Book 1, Sections 2.1, 2.2.1.1, 2.2.1.4, 2.2.1.5, 2.2.2, 2.3.2, 2.3.3, 2.3.1, 2.7, 2.6.1	
3	**Accelerator Techniques**		**12**
	1	High voltage DC accelerators, Cascade generator, Van de Graaff accelerator, Tandem Van de Graaff accelerator, Linear accelerator,	3
	2	Cyclotron, Synchrotron (Electron and proton)	3
	3	Ion sources – Ionization processes, simple ion source, ion plasma source and RF ion source,	3
	4	Ion implantation – techniques and profiles, Ion beam sputtering–principles and applications.	3
		Book 1, Sections 4.3, 4.4, 4.5.1, 4.5.4, 4.5.5, 4.6, 4.8.1 – 4.8.3, 4.9	
4	**Nuclear Radiation Detectors And X- Ray Diffraction Techniques**		**14**
	1	Gas detectors – Ionization chamber, Proportional counter and G M counter, Scintillation detector,	3
	2	Photo Multiplier Tube (PMT), Semiconductor detectors – Ge(Li), Si(Li) and surface barrier detectors, Preamplifiers, Amplifiers, Single channel analysers, multi-channel analysers, counting statistics, energy measurements.	4
	3	Introduction, Lattice planes and Bragg's Law, Diffractometer - Instrumentation, Single, crystal and Powder diffraction, Scherrer equation, Structure factor.	3
	4	Applications of XRD - Crystallinity, Unit Cell Parameters, Phase transition studies, thin film studies, Awareness on Powder Diffraction File (PDF) of the International Centre for Diffraction Data.	4
		Book 2, **Book 3**	
5	**Teacher Specific Module**		**12**
	Directions		
	Advanced applications of experimental techniques		

Essential Readings:

1. Advanced Experimental Techniques in Modern Physics by K M Varier, 2023.
2. Nuclear Radiation Detectors by S S Kapoor and V S Ramamurthy, Wiley eastern, 1986.
3. Elements of Modern X-ray Physics, Jens Als Nielsen and Des McMorrow, John Wiley and Sons, 2000.

Suggested Readings:

1. Scientific foundations of vacuum techniques – S. Dushman and J.M. Laffer, John Wiley New York (1962)
2. Thin film phenomena – K.L. Chopra, Mc Graw Hill (1983)
3. R. Berry, P.M. Hall and M.T. Harris – Thin film technology – Van Nostrand (1968)
4. Dennis and Heppel – Vacuum system design
5. Nuclear Micro analysis – V. Valkovic
6. B.D. Cullity, Elements of X-ray diffraction, Addison Wesley Inc (1978)

Assessment Rubrics:

Evaluation Type		Marks
ESE		**70**
CCA		**30**
a)	*Test Paper	10
b)	**Assignment/ Book- Article Review	10
c)	Seminar/ Viva -Voce	10
Total		**100**

*Best out of two test papers

** or any other activities like quiz, open book exam, group activity

****