M Sc PHYSICS

LOCF SYLLABUS 2023

Department of Physics

School of Physical Sciences

St. Joseph's College (Autonomous)

Tiruchirappalli - 620002, Tamil Nadu, India

SCHOOLS OF EXCELLENCE WITH CHOICE BASED CREDIT SYSTEM (CBCS) POSTGRADUATE COURSES

St. Joseph's College (Autonomous), an esteemed institution in the realm of higher education in India, has embarked on a journey to uphold and perpetuate academic excellence. One of the pivotal initiatives in this pursuit is the establishment of five Schools of Excellence commencing from the academic year 2014-15. These schools are strategically designed to confront and surpass the challenges of the 21st century.

Each School amalgamates correlated disciplines under a unified umbrella, fostering synergy and coherence. This integrated approach fosters the optimal utilization of both human expertise and infrastructure. Moreover, it facilitates academic fluidity and augments employability by nurturing a dynamic environment conducive to learning and innovation. Importantly, while promoting collaboration and interdisciplinary study, the Schools of Excellence also uphold the individual identity, autonomy, and distinctiveness of every department within.

The overarching objectives of these five schools are as follows:

1. Optimal Resource Utilization: Ensuring the efficient use of both human and material resources to foster academic flexibility and attain excellence across disciplines.

2. Horizontal Mobility for Students: Providing students with the freedom to choose courses aligning with their interests and facilitating credit transfers, thereby enhancing their academic mobility and enriching their learning experience.

3. Credit-Transfer Across Disciplines (CTAD): The existing curricular structure, compliant with regulations from entities such as TANSCHE and other higher educational institutions, facilitates seamless credit transfers across diverse disciplines. This underscores the adaptability and uniqueness of the choice-based credit system.

4. Promotion of Human Excellence: Nurturing excellence in specialized areas through focused attention and resources, thus empowering individuals to excel in their respective fields.

5. Emphasis on Internships and Projects: Encouraging students to engage in internships and projects, serving as stepping stones toward research endeavors, thereby fostering a culture of inquiry and innovation.

6. Addressing Stakeholder Needs: The multi-disciplinary nature of the School System is tailored to meet the requirements of various stakeholders, particularly employers, by equipping students with versatile skills and competencies essential for success in the contemporary professional landscape.

In essence, the Schools of Excellence at St. Joseph's College (Autonomous) epitomize a holistic approach towards education, aiming not only to impart knowledge but also to cultivate critical thinking, creativity, and adaptability – qualities indispensable for thriving in the dynamic global arena of the 21st century.

Credit system

The credit system at St. Joseph's College (Autonomous) assigns weightage to courses based on the hours allocated to each course. Typically, one credit is equivalent to one hour of instruction per week. However, credits are awarded regardless of actual teaching hours to ensure consistency and adherence to guidelines.

The credits and hours allotted to each course within a programme are detailed in the Programme Pattern table. While the table provides a framework, there may be some flexibility due to practical sessions, field visits, tutorials, and the nature of project work.

For postgraduate (PG) courses, students are required to accumulate a minimum of 110 credits, as stipulated in the programme pattern table. The total minimum number of courses offered by the department is outlined in the Programme Structure.

OUTCOME-BASED EDUCATION (OBE)

OBE is an educational approach that revolves around clearly defined goals or outcomes for every aspect of the educational system. The primary aim is for each student to successfully achieve these predetermined outcomes by the culmination of their educational journey. Unlike traditional methods, OBE does not prescribe a singular teaching style or assessment format. Instead, classes, activities, and evaluations are structured to support students in attaining the specified outcomes effectively.

In OBE, the emphasis lies on measurable outcomes, allowing educational institutions to establish their own set of objectives tailored to their unique context and priorities. The overarching objective of OBE is to establish a direct link between education and employability, ensuring that students acquire the necessary skills and competencies sought after by employers.

OBE fosters a student-centric approach to teaching and learning, where the delivery of courses and assessments are meticulously planned to align with the predetermined objectives and outcomes. It places significant emphasis on evaluating student performance at various levels to gauge their progress and proficiency in meeting the desired outcomes.

Here are some key aspects of Outcome-Based Education:

Course: A course refers to a theory, practical, or a combination of both that is done within a semester.

Course Outcomes (COs): These are statements that delineate the significant and essential learning outcomes that learners should have achieved and can reliably demonstrate by the conclusion of a course. Typically, three or more course outcomes are specified for each course, depending on its importance.

Programme: This term pertains to the specialization or discipline of a degree programme.

Programme Outcomes (POs): POs are statements that articulate what students are expected to be capable of by the time they graduate. These outcomes are closely aligned with Graduate Attributes.

Programme Specific Outcomes (PSOs): PSOs outline the specific skills and abilities that students should possess upon graduation within a particular discipline or specialization.

Programme Educational Objectives (PEOs): PEOs encapsulate the expected accomplishments of graduates in their careers, particularly highlighting what they are expected to achieve and perform during the initial years postgraduation.

LEARNING OUTCOME-BASED CURRICULUM FRAMEWORK (LOCF)

The Learning Outcomes-Centric Framework (LOCF) places the learning outcomes at the forefront of curriculum design and execution. It underscores the importance of ensuring that these outcomes are clear, measurable, and relevant. LOCF orchestrates teaching methodologies, evaluations, and activities in direct correlation with these outcomes. Furthermore, LOCF adopts a backward design approach, focusing on defining precise and attainable learning objectives. The goal is to create a cohesive framework where every educational element is in harmony with these outcomes.

Assessment practices within LOCF are intricately linked to the established learning objectives. Evaluations are crafted to gauge students' achievement of these outcomes accurately. Emphasis is often placed on employing authentic assessment methods, allowing students to showcase their learning in real-life scenarios. Additionally, LOCF frameworks emphasize flexibility and adaptability, enabling educators to tailor curriculum and instructional approaches to suit the diverse needs of students while ensuring alignment with the defined learning outcomes.

Some important terminologies

Core Courses (CC): *These are compulsory courses that students must undertake as essential components of their curriculum, providing fundamental knowledge within their primary discipline. Including core courses is essential to maintain a standardized academic programme, ensuring recognition and consistency across institutions.*

Common Core (CC): *A common core course is a shared educational element encompassing fundamental topics across disciplines within a school. It promotes interdisciplinary comprehension and collaboration among students by providing a foundational understanding of key subjects essential for academic and professional success across diverse fields of study.*

Elective Courses (ES): *Elective courses are offered within the main discipline or subject of study. They allow students to select specialized or advanced options from a range of courses, offering in-depth exposure to their chosen area of study. Typically, ES are more applied in nature and provide a deeper understanding of specific topics.*

Generic Elective Courses (EG): *These elective courses are chosen from disciplines unrelated to the student's main area of study, aiming to broaden their exposure and knowledge base. As per the Choice Based Credit System (CBCS) policy, students may opt for generic elective courses offered by other disciplines within the college, enhancing the diversity of their learning experience.*

Ability Enhancement Course (AE): *AE is designed to enhance skills and proficiencies related to the student's main discipline. It aims to provide practical training and hands-on experience, contributing to the overall development of students pursuing academic programmes.*

Skill Enhancement Course (SE): *SE focus on developing specific skills or proficiencies relevant to students' academic pursuits. While it is open to students from any discipline, SE is particularly beneficial for those within the related academic programme.*

Self-paced Learning (SP): *This course promotes independent learning habits among students and they have to undergo the course outside the regular class hours within a specified timeframe.*

Comprehensive Examinations (CE): *These examinations cover detailed syllabi comprising select units from courses offered throughout the programme. They are designed to assess crucial knowledge and content that may not have been covered extensively in regular coursework.*

Extra Credit Courses: *To support students in acquiring knowledge and skills through online platforms such as Massive Open Online Courses (MOOCs), additional credits are granted upon verification of course completion. These extra credits can be availed across five semesters (2 - 6). In line with UGC guidelines, students are encouraged to enhance their learning by enrolling in MOOCs offered by portals like SWAYAM, NPTEL, and others. Additionally, certificate courses provided by the college are also considered for these extra credits.*

Outreach Programme (OR): *It is a compulsory course to create a sense of social concern among all the students and to inspire them to dedicated service to the needy.*

Course Coding

The following code system (10 alphanumeric characters) is adopted for Postgraduate courses:

23	UXX	0	XX	00/X
Year of Revision	PG Department Code	Semester Number	Course Specific Initials*	Running Number/with Choice

***Course Specific Initials**

CC - Core Course

CP - Core Practical

ES - Elective

AE - Ability Enhancement Course

SP - Self-paced Learning

EG - Generic Elective

PW - Project and Viva Voce

CE - Comprehensive Examination

OR - Outreach Programme

IS - Internship

EVALUATION PATTERN

Continuous Internal Assessment

Sl No	Component	Marks Alloted
1	Mid Semester Test	30
2	End Semester Test	30
3	*Three Components (15 + 10 + 10)	35
4	Library Referencing (30 hours)	5
	Total	**100**

Passing minimum: 50 marks

* *The first component is a compulsory online test (JosTEL platform) comprising 15 multiple choice questions (10 questions at K1 level and 5 questions at K2 level); The second and the third components are decided by the course in-charge.*

Question Paper Blueprint for Mid and End Semester Tests

<table>
<tr><td colspan="8">Duration: 2 Hours</td><td>Maximum Marks: 60</td></tr>
<tr><td colspan="2" rowspan="2">Section</td><td colspan="6">K levels</td><td rowspan="2">Marks</td></tr>
<tr><td>K1</td><td>K2</td><td>K3</td><td>K4</td><td>K5</td><td>K6</td></tr>
<tr><td colspan="2">A (compulsory)</td><td>7</td><td></td><td></td><td></td><td></td><td></td><td>7 × 1 = 7</td></tr>
<tr><td colspan="2">B (compulsory)</td><td></td><td>5</td><td></td><td></td><td></td><td></td><td>5 × 3 = 15</td></tr>
<tr><td colspan="2">C (either…or type)</td><td></td><td></td><td>3</td><td></td><td></td><td></td><td>3 × 6 = 18</td></tr>
<tr><td rowspan="4">D (2 out of 3)</td><td>For courses with K5 as the highest cognitive level, one K4 and one K5 question is compulsory. (Note: two questions on K4 and one question on K5)</td><td></td><td></td><td></td><td>1</td><td>1*</td><td></td><td rowspan="4">2 × 10 = 20</td></tr>
<tr><td rowspan="3">For courses with K6 as the highest cognitive level: Mid Sem: two questions on K4 and one question on K5; End Sem: two questions on K5 and one question on K6)</td><td></td><td></td><td></td><td colspan="2">Mid Sem</td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td colspan="2">End Sem</td></tr>
<tr><td></td><td></td><td></td><td>1</td><td>1</td><td>1*</td></tr>
<tr><td colspan="8">Total</td><td>60</td></tr>
</table>

* *Compulsory*

Question Paper Blueprint for Semester Examination

Duration: 3 Hours						**Maximum Marks: 100**
UNIT	**Section A** *(Compulsory)*	**Section B** *(Compulsory)*	**Section C** *(Either…or type)*	**Section D** *(3 out of 5)*		
	K1	**K2**	**K3**	**K4**	**K5**	**K6**
UNIT I	2	2	2	2*	2*	1*
UNIT II	2	2	2			
UNIT III	2	2	2			
UNIT IV	2	2	2			
UNIT V	2	2	2			
Marks	**10 × 1 = 10**	**10 × 3 = 30**	**5 × 6 = 30**	**3 × 10 = 30**		

** For courses with K6 as the highest cognitive level wherein one question each on K4, K5 and K6 is compulsory.*
(Note: two questions each on K4 and K5 and one question on K6)

Evaluation Pattern for One/Two-credit Courses

Title of the Course	CIA	Semester Examination	Total Marks
• Ability Enhancement Course	20 + 10 + 20 = 50	50 *(A member from the Department other than the course instructors)*	100
• Self-paced Learning • Comprehensive Examination	25 + 25 = 50	50 *(CoE)*	100
• Internship	100	-	100
• Skill Enhancement Course: Soft Skills	100	-	100
• Project Work and Viva Voce	100	100	100

Grading System

The marks obtained in the CIA and semester for each course will be graded as per the scheme provided in Table - 1.

From the second semester onwards, the total performance within a semester and the continuous performance starting from the first semester are indicated by Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA), respectively. These two are calculated by the following formulae:

$$SGPA \ \ and \ \ CGPA = \frac{\sum_{i=1}^{n} C_i Gp_i}{\sum_{i=1}^{n} C_i}$$

$$WAM = \frac{\sum_{i=1}^{n} C_i M_i}{\sum_{i=1}^{n} C_i}$$

Where,

Ci - credit earned for the Course i

Gpi - Grade Point obtained for the Course i

Mi - Marks obtained for the Course i

n - Number of Courses passed in that semester

WAM - Weighted Average Marks

Table - 1: Grading of the Courses

Mark Range	Grade Point	Corresponding Grade
90 and above	10	O
80 and above and below 90	9	A+
70 and above and below 80	8	A
60 and above and below 70	7	B+
50 and above and below 60	6	B
Below 50	0	RA

Table - 2: Grading of the Final Performance

CGPA	Grade	Performance
9.00 and above	O	Outstanding*
8.00 to 8.99	A+	Excellent*
7.00 to 7.99	A	Very Good
6.00 to 6.99	B+	Good
5.00 to 5.99	B	Above Average
Below 5.00	RA	Re-appear

**The Candidates who have passed in the first appearance and within the prescribed duration of the PG programme are eligible. If the Candidates Grade is O/A+ with more than one attempt, the performance is considered "Very Good".*

Vision

Forming globally competent, committed, compassionate and holistic persons, to be men and women for others, promoting a just society.

Mission

- Fostering learning environment to students of diverse background, developing their inherent skills and competencies through reflection, creation of knowledge and service.
- Nurturing comprehensive learning and best practices through innovative and value- driven pedagogy.
- Contributing significantly to Higher Education through Teaching, Learning, Research and Extension.

Programme Educational Objectives (PEOs)

1. Graduates will be able to accomplish professional standards in the global environment.
2. Graduates will be able to uphold integrity and human values.
3. Graduates will be able to appreciate and promote pluralism and multiculturalism in working environment.

Programme Outcomes (POs)

1. Graduates will be able to apply assimilated knowledge to evolve tangible solution to emerging problems.
2. Graduates will be able to analyze and interpret data to create and design new knowledge.
3. Graduates will be able to engage in innovative and socially relevant research and effectively communicate the findings.
4. Graduates will become ethically committed professional and entrepreneurs upholding human values.
5. Graduates imbibed with ethical values and social concern will be able to understand and appreciate cultural diversity, social harmony and ensure sustainable environment.

Programme Specific Objectives (PSOs)

1. Gain the ability to identify and analyse complex Physics problems using the principles of Physics with suitable mathematical tools.
2. Acquire skills which will put the learners at an advantage in careers as drivers to associate with different subjects.
3. Mould to adopt, absorb and develop innovative ideas
4. Develop skills to communicate effectively with peers, professionals and society at large and demonstrate professional ethics
5. Exhibit effective individual talent, and engage themselves in lifelong learning and dissemination

PROGRAMME STRUCTURE				
Semester	**Course Specification**	**Number of Courses**	**Hours**	**Credits**
1 - 4	Core Course	9	45	45
1 - 4	Core Practical	4	30	24
1, 2, 4	Elective	4	20	14
1	Ability Enhancement Course	1	2	1
2	Self-paced Learning	1	-	2
2	Skill Enhancement Course	1	4	3
2, 3	Generic Elective	2	8	6
3	Common Core	1	5	4
2 - 4	Extra Credit Course	3	-	(9)
4	Project Work and Viva Voce	1	6	5
4	Comprehensive Examination	1	-	2
2 - 4	Outreach Programme (SHEPHERD)	-	-	4
	Total	**28**	**120**	**110(9)**

M Sc PHYSICS							
Course Details					Scheme of Exams		
Sem	**Course Code**	**Title of the Course**	**Hours**	**Credits**	**CIA**	**SE**	**Final**
1	23PPH1CC01	**Core Course - 1**: Mathematical Physics	6	6	100	100	100
	23PPH1CC02	**Core Course - 2**: Classical Mechanics and Relativity	6	6	100	100	100
	23PPH1CP01	**Core Practical - 1**: Physics Practical - 1	6	4	100	100	100
	23PPH1ES01	**Elective - 1:** Linear and Digital ICs and Applications	5	3	100	100	100
	23PPH1ES02	**Elective - 2:** Physics of Nano Science and Technology	5	3	100	100	100
	23PPH1AE01	**Ability Enhancement Course:** Framework for Physics Innovation and Entrepreneurship	2	1	100	-	100
		Total	**30**	**23**			
2	23PPH2CC03	**Core Course - 3**: Quantum Mechanics	5	5	100	100	100
	23PPH2CC04	**Core Course - 4**: Molecular Spectroscopy	4	4	100	100	100
	23PPH2CP02	**Core Practical - 2**: Physics Practical - 2	8	6	100	100	100
	23PPH2SP01A	**Self-paced Learning:** Medical Physics*	-	2	50	50	50
	23PPH2SP01B	**Self-paced Learning:** Crystal Growth and Thin Films*					
	23PPH2SP01C	**Self-paced Learning:** Ultrasonics and its Applications*					
	23PPH2SP01D	**Self-paced Learning:** Forensic Physics*					
	23PPH2ES03A	**Elective - 3:** Mathematical Methods of Computational Physics and Python Programming	5	4	100	100	100
	23PPH2ES03B	**Elective - 3:** Physics of Disaster Management					
	23PSS2SE01	**Skill Enhancement Course:** Soft Skills	4	3	100	-	100
	-	**Generic Elective - 1 (WS):** Refer ANNEXURE 1	4	3	100	100	100
	-	Extra Credit Courses (MOOC/Certificate Courses) - 1	-	(3)			
		Total	**30**	**27(3)**			
3	23PPH3CC05	**Core Course - 5**: Electromagnetic Theory	5	5	100	100	100
	23PPH3CC06	**Core Course - 6**: Condensed Matter Physics	4	4	100	100	100
	23PPH3CC07	**Core Course - 7**: Fiber Optic Communication	4	4	100	100	100
	23PPH3CP03	**Core Practical - 3**: Physics Practical - 3	8	8	100	100	100
	23SPS3CC01	**Common Core:** Materials Science	5	4	100	100	100
	-	**Generic Elective - 2 (BS):** Refer ANNEXURE 2	4	3	100	100	100
	-	Extra Credit Courses (MOOC/Certificate Courses) - 2		(3)			
		Total	**30**	**28(3)**			
4	23PPH4CC08	**Core Course - 8**: Nuclear and Particle Physics	6	6	100	100	100
	23PPH4CC09	**Core Course - 9**: Statistical Mechanics and Thermodynamics	5	5	100	100	100
	23PPH4CP04	**Core Practical - 4**: Physics Practical - 4	8	6	100	100	100
	23PPH4ES03A	**Elective - 4:** Microcontroller Based Physics Instrumentation	5	4	100	100	100
	23PPH4ES03B	**Elective - 4:** Physics of Sensors and Transducers					
	23PPH4PW01	Project Work and Viva Voce	6	5	100	100	100
	23PPH4CE01	Comprehensive Examination*	-	2	50	50	50
	-	Extra Credit Courses (MOOC/Certificate Courses) - 3	-	(3)			
		Total	**30**	**28(3)**			
2 - 4	23PCW4OR01	Outreach Programme (SHEPHERD)		4			
1 - 4		**Total**	**120**	**110(9)**			

*- for grade calculation 50 marks are converted into 100 in the mark statements

Passed by	***Board of Studies held on 18.12.2023***
Approved by	***48th Academic Council Meeting held on 27.03.2024***

ANNEXURE 1

Generic Elective - 1 (WS)*

Course Details		
School	**Course Code**	**Title of the Course**
SPS	23PCH2EG01A	Chemistry for Physical Sciences - 1
	23PCH2EG01B	Chemistry for Physical Sciences - 2
	23PEL2EG01	Electronics Media

**Offered to students from other Departments within School*

ANNEXURE 2
Generic Elective - 1 (BS)*

Course Details		
School	**Course Code**	**Title of the Course**
SBS	23PBI3EG02	First Aid Management
	23PBT3EG02	Food Technology
	23PBO3EG02	Horticulture and Landscaping
SCS	23PCA3EG02	Web Design
	23PCS3EG02	Advances in Computer Science
	23PDS3EG02	Information Security and Ethics
	23PMA3EG02	Operations Research
SLAC	23PEN3EG02	English for Effective Communication
SMS	23PCO3EG02	Basics of TallyPrime
	23PCC3EG02	Dynamics of Human Behaviour in Business
	23PCP3EG02	Social Psychology
	23PEC3EG02	Managerial Economics
	23PHR3EG02	Counselling and Guidance

**Offered to students from other Schools*

Semester	Course Code	Title of the Course	Hours/ Weeks	Credits
1	23PPH1CC01	**Core Course - 1:** Mathematical Physics	6	6

Course Objectives
To equip students with the mathematical techniques needed for understanding theoretical treatment in different courses taught in their program
To extend their manipulative skills to apply mathematical techniques in their fields
To help students apply Mathematics in solving problems of Physics
To simplify the given complex problems on 2nd order ODE in terms simple special function solutions
To interpret the essence of various complex mathematical forms in physics

UNIT I: Linear Vector Spaces (18 Hours)

Basic concepts – Definitions- examples of vector space – Linear independence - Scalar product-Orthogonality – Gram-Schmidt orthogonalization procedure –linear operators – Dual space- ket and bra notation – orthogonal basis – change of basis – Isomorphism of vector space – projection operator – Eigen values and Eigen functions – Direct sum and invariant subspace – orthogonal transformations and rotation

UNIT-II: Complex Analysis (18 Hours)

Review of Complex Numbers -de Moivre's theorem-Functions of a Complex Variable- Differentiability -Analytic functions- Harmonic Functions- Complex Integration- Contour Integration, Cauchy – Riemann conditions – Singular points – Cauchy's Integral Theorem and integral Formula -Taylor's Series-Laurent's Expansion- Zeros and poles – Residue theorem and its Application: Potential theory-(1) Electrostatic fields and complex potentials Parallel plates, coaxial cylinders and an annular region (2) Heat problems-Parallel plates and coaxial cylinders

UNIT III: Matrices (18 Hours)

Types of Matrices and their properties, Rank of a Matrix -Conjugate of a matrix-Adjoint of a matrix-Inverse of a matrix-Hermitian and Unitary Matrices -Trace of a matrix- Transformation of matrices-Characteristic equation-Eigen values and Eigen vectors-Cayley– Hamilton theorem –Diagonalization.

UNIT IV: Fourier & Laplace Transforms (18 Hours)

Definitions -Fourier transform and its inverse-Transform of Gaussian function and Dirac delta function -Fourier transform of derivatives-Cosine and sine transforms-Convolution theorem. Application: Diffusion equation: Flow of heat in an infinite and in a semi-infinite medium-Wave equation: Vibration of an infinite string and of a semi-infinite string. Laplace transform and its inverse-Transforms of derivatives and integrals – Differentiation and integration of transforms-Dirac delta functions-Application-Laplace equation: Potential problem in a semi-infinite strip

UNIT V: Second Order Differential Equations & Special Functions (18 Hours)

Second order differential equation- Sturm-Liouville'stheory-Series solution with simple examples-Hermite polynomials-Generating function-Orthogonality properties-Recurrence relations – Legendre polynomials-Generating function-Rodrigue formula – Orthogonality properties- Dirac delta function-One dimensional Green's function and Reciprocity theorem -Sturm-Liouville's type equation in one dimension & their Green's function.

Teaching Methodology	Chalk and talk, PPT, Mathematical models, Graphical representation using software, simulation

Books for Study

1. Zettile, N. (2009). *Quantum mechanics: Concepts and applications,* (2nd Ed.). John Wiley & Sons.
2. Arfken, G., & Weber, H. J. (2012). *Mathematical methods for physicists – A comprehensive guide,* (7th Ed.). Academic press.
3. Chattopadhyay, P. K. (2013). *Mathematical physics,* (2nd Ed.). New Age.
4. Joshi, A. W. (2017). *Matrices and tensors in physics,* (4th Ed.). New Age International Pvt. Ltd.
5. Gupta, B. D. (2009). *Mathematical physics*. Vikas Publishing House.

6. Dass, H. K., & Verma, R. (2014). *Mathematical physics,* (7th Revised Ed.). S. Chand & Company Pvt. Ltd.

Books for Reference

1. Kreyszig, E. (1983). *Advanced Engineering Mathematics*. Wiley Eastern.
2. Zill, D. G., & Cullen, M. R. (2006). *Advanced Engineering Mathematics,* (3rd Ed.). Narosa.
3. Lipschutz, S. (1987). *Linear algebra*. Schaum's Series. McGraw Hill.
4. Butkov, E. (1968). *Mathematical physics*. Addison - Wesley, Reading, Massachusetts.
5. Halmos, P. R. (1965). *Finite dimensional vector spaces,* (2nd Ed.). Affiliated East West.
6. Wylie, C. R., & Barrett, L. C. (1995). *Advanced Engineering Mathematics,* (6th Ed.). International Edition, McGraw-Hill.

Websites and eLearning Sources

1. www.khanacademy.org
2. https://youtu.be/LZnRlOA1_2I
3. http://hyperphysics.phy-astr.gsu.edu/hbase/hmat.html#hmath
4. https://www.youtube.com/watch?v=_2jymuM7OUU&list=PLhkiT_RYTEU27vS_SlE D56gNjVJGO2qaZ
5. https://archive.nptel.ac.in/courses/115/106/115106086/

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K-Level)**
CO1	understand use of bra-ket vector notation, the meaning of complete orthonormal set of basis vectors, and transformations and be able to apply them	**K1**
CO2	understand analytic functions, do complex integration, by applying Cauchy Integral Formula. And to compute many real integrals and infinite problems via complex integration	**K2**
CO3	analyze characteristics of matrices and its different types, and the process of diagonalization.	**K3**
CO4	solve equations using Laplace transform and analyze the Fourier transformations of different function, grasp how these transformations can speed up analysis and correlate their importance in technology	**K4**
CO5	find the solutions for physical problems using linear differential equations and to solve boundary value problems using Green's function. Apply special functions in computation of solutions to real world problems	**K5**
CO6	formulate and propose the best solution for handling complex ODE problems	**K6**

Relationship Matrix

Semester	**Course Code**	**Title of the Course**								**Hours**	**Credits**
1	**23PPH1CC01**	**Core Course - 1:** Mathematical Physics								**6**	**6**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	2	2	1	3	3	3	2	2	**2.4**
CO2	3	3	3	2	2	3	3	3	2	2	**2.5**
CO3	3	3	3	2	2	3	3	3	2	2	**2.5**
CO4	3	3	2	2	2	3	3	3	2	2	**2.5**
CO5	3	3	3	3	2	3	3	3	2	2	**2.7**
CO6	3	3	2	3	2	3	3	3	2	2	**2.6**
Mean Overall Score											**2.53 (High)**

Semester	Course Code	Title of the Course	Hours/ Weeks	Credits
1	23PPH1CC02	**Core Course - 2:** Classical Mechanics and Relativity	6	6

Course Objectives
To make the students to understand fundamentals of classical mechanics
To extend the Lagrangian formulation of mechanics and help the students to apply it to solve equation of motion
To equip the students with Hamiltonian formulation of mechanics and help them to apply it to solve equation of motion
To discuss the theory of small oscillations of a system
To learn the relativistic formulation of mechanics of a system

UNIT I: Principles of Classical Mechanics (18 Hours)
Mechanics of a single particle – mechanics of a system of particles – conservation laws for a system of particles – constraints – holonomic & non-holonomic constraints – generalized coordinates configuration space – transformation equations – principle of virtual work.

UNIT II: Lagrangian Formulation (18 Hours)
D'Alembert's principle – Lagrangian equations of motion for conservative systems – applications: (i) simple pendulum (ii) Atwood's machine (iii) projectile motion- iv) compound pendulum - linear harmonic oscillator Lagrange's equations in presence of nonconservative forces - generalized potential - Lagrangian of a charged particle in the presence of electromagnetic field - Hamilton's principle - Lagrange's equation of motion from Hamilton's principle - conservation theorems and symmetry properties.

UNIT III: Hamiltonian Formulation (18 Hours)
Phase space – cyclic coordinates – conjugate momentum – Hamiltonian function – Hamilton's canonical equations of motion – applications: (i) simple pendulum (ii) one dimensional simple harmonic oscillator (iii) compound pendulum - linear harmonic oscillator iv) motion of particle in a central force field. - Δ-variation - principle of least action- statement and its proof - other forms of the action principle (Jacobi's form).

UNIT IV: Small Oscillations (18 Hours)
Formulation of the problem – the Eigen value equation and principle axis transformation – frequency of free vibration and normal coordinates transformation – frequencies of normal modes – linear triatomic molecule – forced vibration and effect of dissipative forces.

UNIT V: Relativity (18 Hours)
Inertial and non-inertial frames – Lorentz transformation equations – length contraction and time dilation – relativistic addition of velocities – Einstein's mass-energy relation – Minkowski's space – four vectors – position, velocity, momentum, acceleration and force in for vector notation and their transformations

Teaching Methodology	Chalk and talk, PPT, Mathematical models, Graphical representation using software, simulation

Books for Study

1. Goldstein, H., & Poole, C. P. (2002). *Classical mechanics,* (3rd Ed.). Dorling Kindersley (India) Pvt. Ltd.
2. Upadhyaya, J. C. (2022). *Classical mechanics,* (3rd Ed.). Himalaya Publishing Company.
3. Resnick, R. (1968). *Introduction to special theory of relativity*. Wiley Eastern.
4. Takwala, R. G., & Puranik, P. S. (1980). *Introduction to classical mechanics*.Tata McGraw-Hill.
5. Rana, N. C., & Joag, P. S. (2001). *Classical mechanics*. Tata McGraw-Hill.

Books for Reference

1. Symon, K. R. (1971). *Mechanics*. Addison Wesley.
2. Biswas, S. N. (1999). *Classical mechanics*. Books & Allied, Kolkata.
3. Gupta, B. D., & Prakash, S. (2020). *Classical mechanics*. KNRN Publications.
4. Kibble, T. W. B. (2004). *Classical mechanics*. Imperial College Press.
5. Greenwood, T. (1997). *Classical dynamics*. PHI.

Websites and eLearning Sources

1. http://poincare.matf.bg.ac.rs/~zarkom/Book_Mechanics_Goldstein_Classical_Mechanics_optimized.pdf
2. https://pdfcoffee.com/classical-mechanics-j-c-upadhyay-2014-editionpdf-pdffree.html
3. https://nptel.ac.in/courses/122/106/122106027/
4. https://ocw.mit.edu/courses/physics/8-09-classical-mechanics-iii-fall-2014/lecturenotes/
5. https://www.britannica.com/science/relativistic-mechanics

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K-Level)**
CO1	acquire knowledge about conservation laws, constraints and relativistic mechanics.	**K1**
CO2	understand relativistic mechanics, D' Alemberts concept and Lagrangian.	**K2**
CO3	analyse the cyclic coordinates and apply them for rigid body dynamics.	**K3**
CO4	apply and formulate the equation to solve problems in mechanics and relativistic mechanics.	**K4**
CO5	evaluate the concepts of inertial, non-inertial frames of references and rotating coordinate system in relativistic mechanics.	**K5**
CO6	distinguish the transformation equations in any frame.	**K6**

Relationship Matrix

Semester	Course Code	Title of the Course							Hours	Credits
1	23PPH1CC02	**Core Course - 2:** Classical Mechanics and Relativity							6	6
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**				**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	2	3	2	2	2	3	3	2	1	**2.3**
CO2	3	3	3	2	2	2	2	2	2	2	**2.3**
CO3	3	2	2	2	2	2	2	3	2	2	**2.2**
CO4	2	2	2	2	2	3	2	2	2	2	**2.1**
CO5	2	3	3	2	2	3	2	2	2	2	**2.3**
CO6	2	2	2	3	2	3	2	2	2	2	**2.2**
Mean Overall Score											**2.23 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
1	23PPH1CP01	**Core Practical -1:** Physics Practical - 1	6	4

ANY 12 EXPERIMENTS

1. Determination of Young's modulus and Poisson's ratio by Hyperbolic fringes – Cornu's Method
2. Measurement of Band gap energy- Thermistor
3. Determination of Specific charge of an electron – Thomson's method
4. Determination of Wavelength, Separation of wavelengths - Michelson Interferometer
5. GM counter – Characteristics and inverse square law
6. Measurement of Conductivity - Four probe method
7. Molecular spectra – AlO band.
8. Measurement of wavelength of Diode Laser / He – Ne Laser using Diffraction grating
9. Measurements of Standing wave and standing wave co-efficient, Law of Inverse square, Receiver end transmitter behavior, Radiation Pattern - Microwave test bench
10. UV-Visible spectroscopy – Verification of Beer-Lambert's law and identification of wavelength maxima – Extinction coefficient
11. Construction of relaxation oscillator using UJT
12. FET CS amplifier- Frequency response, input impedance, output impedance
13. V- I Characteristics of different colours of LED
14. Study of attenuation characteristics of Wien's bridge network and design of Wien's bridge oscillator using Op-Amp
15. Study of attenuation characteristics of Phase shift network and design of Phase shift oscillator using Op-Amp
16. Construction of Schmidt trigger circuit using IC 741 for a given hysteresis-application as squarer
17. Study of R-S, clocked R-S and D-Flip flop using NAND gates
18. Study of J-K, D and T flip flops using IC 7476/7473
19. Arithmetic operations using IC 7483- 4-bit binary addition and subtraction.
20. Study of Arithmetic logic unit using IC 74181

Semester	Course Code	Title of the Course	Hours/ Week	Credits
1	23PPH1ES01	**Elective - 1:** Linear and Digital ICs and Applications	5	3

Course Objectives
To introduce the basic building blocks of linear integrated circuits
To teach the linear and non-linear applications of operational amplifiers
To introduce the theory and applications of PLL
To introduce the concepts of waveform generation and introduce one special function ICs
To Expose the digital IC's

UNIT I: Integrated Circuits and Operational Amplifier (15 Hours)
Introduction, Classification of IC 's, basic information of Op-Amp 741 and its features, the ideal Operational amplifier, Op-Amp internal circuit and Op-Amp. Characteristics.

UNIT II: Applications of Op-Amp (15 Hours)
LINEAR APPLICATIONS OF OP-AMP: Solution to simultaneous equations and differential equations, Instrumentation amplifiers, V to I and I to V converters. NON-LINEAR APPLICATIONS OF OP-AMP: Sample and Hold circuit, Log and Antilog amplifier, multiplier and divider, Comparators, Schmitt trigger, Multivibrators, Triangular and Square waveform generators.

UNIT III: Active Filters & Timer and Phase Locked Loops (15 Hours)
ACTIVE FILTERS: Introduction, Butterworth filters – 1st order, 2nd order low pass and high pass filters, band pass, band reject and all pass filters. TIMER AND PHASE LOCKED LOOPS: Introduction to IC 555 timer, description of functional diagram, monostable and a stable operations and applications, Schmitt trigger, PLL - introduction, basic principle, phase detector/comparator, voltage-controlled oscillator (IC 566), low pass filter, monolithic PLL and applications of PLL

UNIT IV: Voltage Regulator & D to A AND A to D Converters (15 Hours)
VOLTAGE REGULATOR: Introduction, Series Op-Amp regulator, IC Voltage Regulators, IC 723 general purpose regulators, Switching Regulator. D to A AND A to D CONVERTERS: Introduction, basic DAC techniques -weighted resistor DAC, R-2R ladder DAC, inverted R-2R DAC, A to D converters -parallel comparator type ADC, counter type ADC, successive approximation ADC and dual slope ADC, DAC and ADC Specifications.

UNIT V: CMOS Logic, Combinational Circuits using TTL 74XX ICs & Sequential Circuits using TTL 74XX ICs (15 Hours)
CMOS LOGIC: CMOS logic levels, MOS transistors, Basic CMOS Inverter, NAND and NOR gates, CMOS AND-OR-INVERT and OR-AND-INVERT gates, implementation of any function using CMOS logic. COMBINATIONAL CIRCUITS USING TTL 74XX ICs: Study of logic gates using 74XX ICs, Four-bit parallel adder (IC 7483), Comparator (IC 7485), Decoder (IC 74138, IC 74154), BCD to 7-segment decoder (IC7447), Encoder (IC74147), Multiplexer (IC74151), Demultiplexer (IC 74154). SEQUENTIAL CIRCUITS USING TTL 74XX ICs: Flip Flops (IC 7474, IC 7473), Shift Registers, Universal Shift Register (IC 74194), 4- bit asynchronous binary counter (IC 7493).

Teaching Methodology	Videos, PPT, Handouts, circuit analysis, mini projects

Books for Study

1. Choudhury, D. R., & Jain, S. B. (2012). *Linear integrated circuit,* (4th Ed.). New Age International Pvt. Ltd.
2. Gayakwad, R. A. (2012). *OP-AMP and linear integrated circuits,* (4th Ed.). Prentice Hall / Pearson Education.
3. Theraja, B. L., & Theraja, A. K. (2004). *A textbook of electrical technology*. S. Chand & Company.

4. Mehta, V. K., & Mehta, R. (2008). *Principles of electronics,* (12th Ed.). S. Chand & Company.
5. Vijayendran, V. (2008). *Introduction to integrated electronics (Digital & Analog)*. S. Viswanathan Printers & Publishers Private Ltd, Reprint.

Books for Reference

1. Franco, S. (1997). *Design with operational amplifiers and analog integrated circuits.* Tata McGraw-Hill.
2. Gray., & Meyer. (1995). *Analysis and design of analog integrated circuits*. Wiley International.
3. Malvino., & Leach. (2005). *Digital principles and applications,* (5th Ed.). Tata McGraw-Hill.
4. Floyd., & Jain. (2009). *Digital fundamentals,* (8th Ed.). Pearson Education.
5. Millman., & Halkias. (2000). *Integrated electronics*. Tata McGraw Hill, 17th Reprint.

Websites and eLearning Sources

1. https://nptel.ac.in/course.html/digital circuits/
2. https://nptel.ac.in/course.html/electronics/operational amplifier/
3. https://www.allaboutcircuits.com/textbook/semiconductors/chpt-7/field-effectcontrolled-thyristors/
4. https://www.electrical4u.com/applications-of-op-amp/
5. https://www.geeksforgeeks.org/digital-electronics-logic-design-tutorials/

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K-Level)**
CO1	spell out the basic concepts for the circuit configuration and for the design of linear integrated circuits	**K1**
CO2	illustrate various techniques to develop A/D and D/A converters.	**K2**
CO3	explain the design of linear and non-linear applications circuits using Op-Amp.	**K3**
CO4	analyze the CMOS logic, combinational and sequential circuits	**K4**
CO5	evaluate solutions to the problems and compare the active filters circuits	**K5**
CO6	design and create analog and digital circuits for various applications	**K6**

Relationship Matrix										
Semester	**Course Code**	**Title of the Course**						**Hours**		**Credits**
1	**23PPH1ES01**	**Elective - 1:** Linear and Digital ICs and Applications						**5**		**3**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**				**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	3	2	2	3	3	3	2	3	**2.7**
CO2	3	2	2	3	2	3	2	2	3	2	**2.4**
CO3	2	2	2	3	3	2	2	3	3	3	**2.5**
CO4	3	2	3	3	2	2	2	2	2	3	**2.4**
CO5	2	2	2	2	3	2	2	2	2	2	**2.1**
CO6	3	3	2	3	2	2	2	3	3	2	**2.5**
										Mean Overall Score	**2.43 (High)**

Semester	Course Code	Title of the Course	Hours/ Week	Credits
1	23PPH1ES02	**Elective - 2:** Physics of Nano Science and Technology	5	3

Course Objectives
Physics of Nanoscience and Technology is concerned with the study, creation, manipulation and applications at nanometer scale
To provide the basic knowledge about nanoscience and technology
To learn the structures and properties of nanomaterials
To acquire the knowledge about synthesis methods and characterization techniques and its applications
To make the students aware of the application of nanomaterials and nanotechnology in different field

UNIT I: Fundamentals of Nanoscience and Technology (15 Hours)

Fundamentals of NANO – Historical Perspective on Nanomaterial and Nanotechnology -– Classification of Nanomaterials – Metal and Semiconductor Nanomaterials - 2D, 1D, 0D nanostructured materials - Quantum dots – Quantum wires – Quantum wells - Surface effects of nanomaterials.

UNIT II: Properties of Nanomaterials (15 Hours)

Physical properties of Nanomaterials: Melting points, specific heat capacity, and lattice constant - Mechanical behavior: Elastic properties – strength - ductility - superplastic behavior - Optical properties: - Surface Plasmon Resonance – Quantum size effects - Electrical properties - Conductivity, Ferroelectrics and dielectrics - Magnetic properties – super para magnetism – Diluted magnetic semiconductor (DMS).

UNIT III: Synthesis and Fabrication (15 Hours)

Physical vapour deposition - Chemical vapour deposition - sol-gel – Wet deposition techniques - electrochemical deposition method – Plasma arching - Electrospinning method - ball milling technique - pulsed laser deposition - Nanolithography: photolithography – Nanomanipulator.

UNIT IV: Characterization Techniques (15 Hours)

Powder X-ray diffraction – X-ray photoelectron spectroscopy (XPS) - UV-visible spectroscopy – Photoluminescence - Scanning electron microscopy (SEM) - Transmission electron microscopy (TEM) - Scanning probe microscopy (SPM) - Scanning tunneling microscopy (STM) – Vibrating sample Magnetometer.

UNIT V: Applications of Nanomaterials (15 Hours)

Sensors: Nano sensors based on optical and physical properties - Electrochemical sensors – Nano-biosensors. Nano Electronics: Nanobots - display screens - GMR read/write heads - Carbon Nanotube Emitters – Photocatalytic application: Air purification, water purification Medicine: Imaging of cancer cells – biological tags - drug delivery - photodynamic therapy - Energy: fuel cells - rechargeable batteries - supercapacitors - photovoltaics.

Teaching Methodology	Chalk and talk, PPT, Mathematical models, Graphical representation using software, simulation

Books for Study

1. Pradeep, T. (2012). *A textbook of nanoscience and nanotechnology*. Tata McGraw-Hill Publishing Company.
2. Shah, M. A., & Ahmad, T. (2010). *Principles of nanoscience and nanotechnology*. Narosa Publishing House Pvt Ltd.
3. Chattopadhyay, K. K., & Banerjee, A. N. (2012). *Introduction to nanoscience and nanotechnology*. PHI Learning Pvt. Ltd.
4. Nalwa, H. S. (2002). *Nanostructured materials and nanotechnology*. Academic Press.
5. Kothari, D. P., Velmurugan, V., & Singh, R. R. (2018). *Nanotechnology and nanoelectronics*.

Narosa Publishing House Pvt. Ltd.

Books for Reference

1. Rao, M. S. R., & Singh, S. (2017). *Nanoscience and nanotechnology: Fundamentals to frontiers*. Wiley Publishing.
2. Gao, H. (2004). *Nanostructures and nanomaterials*. Imperial College Press.
3. Booker, R., & Boysen, E. (2005). *Nanotechnology*. Wiley Publishing Inc.
4. Fendler, J. H. (2007). *Nano particles and nanostructured films: Preparation, Characterization and Applications*. John Wiley and Sons.
5. Murty, B. S., *et al*. (2012). *Textbook of Nanoscience and Nanotechnology*. Universities Press.
6. Diwan, P., & Bharadwaj, A. (2005). *The Nanoscope (Encyclopedia of nanoscience and nanotechnology).* Vol. IV – Nanoelectronics. Pentagon Press.

Websites and eLearning Sources

1. www.its.caltec.edu/feyman/plenty.html
2. http://www.library.ualberta.ca/subject/nanoscience/guide/index.cfm
3. http://www.understandingnano.com
4. http://www.nano.gov
5. http://www.nanotechnology.com

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K-Level)**
CO1	acquire the basic of nanoscience and explore the different types of nanomaterials and should comprehend the surface effects of the nanomaterials.	**K1**
CO2	understand various physical, mechanical, optical, electrical and magnetic properties nanomaterials.	**K2**
CO3	utilize the process and mechanism of synthesis and fabrication of nanomaterials.	**K3**
CO4	analyze the various characterization of Nano-products through diffraction, spectroscopic, microscopic and other techniques.	**K4**
CO5	evaluate the synthesis and fabrication methods suitable for the application of nanomaterials.	**K5**
CO6	develop the nanomaterials integrated devices in the field of sensors, robotics, purification of air and water and in the energy devices.	**K6**

Relationship Matrix										
Semester	**Course Code**	**Title of the Course**							**Hours**	**Credits**
1	**23PPH1ES02**	**Elective - 2:** Physics of Nano Science and Technology							**5**	**3**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**				**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	3	2	1	3	3	3	2	1	**2.4**
CO2	3	3	3	2	1	3	3	3	2	1	**2.2**
CO3	3	3	2	2	1	3	3	2	2	1	**2.4**
CO4	3	3	3	2	1	3	3	3	2	1	**2.2**
CO5	3	3	2	2	1	3	3	2	2	1	**2.4**
CO6	3	3	3	2	1	3	3	3	2	1	**2.2**
Mean Overall Score											**2.3 (High)**

Semester	Course code	Title of the Course	Hours/Week	Credits
1	23PPH1AE01	**Ability Enhancement Course:** Framework for Physics Innovation and Entrepreneurship	2	1

Course Objectives
To know the fundamentals of research methodologies
To train the students to write research articles and scientific reports
To introduce the innovation and incubator concepts
To create awareness about intellectual properties and their protection
To know the process involved in copy rights and patent registration

UNIT I: Research Methodology (6 Hours)

Meaning and objectives of research- motivation in research- Types of research- Research Approaches- Significance of Research-Research Methods versus Methodology-Research and Scientific Method-research process-Criteria of Good Research

UNIT II: Research Writing (6 Hours)

Significance of report writing -Different steps in writing report- Layout of the research report - Types of reports - Oral presentation -mechanics of writing a research report-precautions for writing research reports - Search engines & research papers – free digital library– Plagiarism

UNIT III: Innovation & Incubators (6 Hours)

Innovation -Managerial Innovation -Open Innovation- **Incubators:** Definitions- Start-ups – Types and characteristics of various incubators of start-ups - The entrepreneurial policy of large groups

UNIT IV: Intellectual Properties (6 Hours)

Intellectual Property: Definition, Types: trademarks, Copyright, Patents, and Trade Secrets Importance-International Organizations, Agencies, and Treaties - **Types of Marks:** Trademarks, Service Marks, Certification Marks, and Collective Marks - Trade Names and Business Names

UNIT V: Copy Rights & Patents (6 Hours)

Copy Rights: Introduction – Originality of Material, Fixation of Material, Works of Authorship - Exclusions from Copyright Protection - **Patents:** Patentability, searching patentsThe Indian patent act 1970.

Teaching Methodology	Chalk and talk, PPT, Mathematical models, Graphical representation using software, simulation

Books for Study

1. Kothari, C. R. (2004). *Research methodology*, (2nd Ed.). New Age International (P) Ltd.
2. Latouche, P. (2019). *Open innovation: Corporate incubator*. ISTE Ltd.
3. Bouchoux, D. E. (2013). *Intellectual Property,* (4th Ed.). Cengage Learning.

Book for Reference

1. Bansal, K., & Bansal, P. (2020). *Fundamentals of Intellectual Property for Engineers*. BS Publication.

Websites and eLearning Sources

1. https://ipindia.gov.in/
2. https://mic.gov.in/assets/doc/startup_policy_2019.pdf

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K-Level)**
CO1	classify various types of reports, intellectual properties, agencies, treaties and public policies.	**K4**
CO2	evaluate situation in research, intellectual property and innovation-incubator system in India.	**K5**
CO3	create a pre-incubation process that involves a technology-based business idea and executing the business model through startup.	**K6**

Relationship Matrix											
Semester	**Course Code**	**Title of the Course**							**Hours**		**Credits**
1	**23PPH1AE01**	**Ability Enhancement Course:** Framework for Physics Innovation and Entrepreneurship							**2**		**1**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	3	2	2	1	3	3	3	3	**2.6**
CO2	3	3	3	2	2	1	3	3	3	3	**2.6**
CO3	3	3	3	2	2	2	3	3	2	3	**2.6**
										Mean Overall Score	**2.6 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
2	**23PPH2CC03**	**Core Course - 3:** Quantum Mechanics	**5**	**5**

Course Objectives
To retrieve the fundamentals and the connection between classical and quantum mechanics.
To infer different square well potentials and eigen value problems.
To execute the problems in cartesian, spherical polar coordinates and angular momentum.
To explain Schrodinger equation, potential well, approximation methods and perturbation theory.
To assess the properties of 1D motion, 3D problems in spherical polar coordinates and transition rates.
To solve quantum mechanical problems.

UNIT I: Basic Postulates and Quantum Systems (15 Hours)

Introduction - The basic postulates of Quantum Mechanics (QM) - The state of a system - observables and operators - Measurement in QM: how measurements disturb systems - expectation values - CSCO - measurement and the uncertainty relation; Time Evolution of the system's state: time evolution operator - stationary states - Schrodinger equation and wave packets - conservation of probability - time evaluation of expectation values; Connecting Quantum Mechanics to Classical Mechanics. Properties of 1D motions: Bound, unbound states, mixed spectrum - The free particle continuous states - the potential step.

UNIT II: One and Three – Dimensional Problems (15 Hours)

The potential barrier & well: E > Vo, E < Vo: Tunelling, tunnelling effect - the infinite square well potential: Asymmetric square - symmetric; the finite square well potential: Scattering solutions (E > Vo), Bound state solution (0 < E < Vo) - Harmonic oscillator: Energy Eigenvalues, Energy Eigen states - 3D problems in Cartesian coordinates: General treatment, free particle - 3D problems in spherical coordinates: central potential, the free particle, the hydrogen atom.

UNIT III: Angular Momentum (15 Hours)

General formalism - Geometrical representation - Spin angular momentum: Experimental evidence of spin, general theory of spin, spin ½ and Pauli Matrices - Eigen functions of orbital angular momentum: Eigen functions and Eigenvalues of Lz, Eigen functions of L^2 - Addition of Angular Momenta: General formalism of CG Coefficient.

UNIT IV: Approximation Methods for Stationary States (15 Hours)

Time independent Perturbation Theory: Non-degenerate, Degenerate - Variational method - JWKB method: General formalism, bound states for potential wells with NO and ONE rigid walls, tunnelling through potential barrier.

UNIT V: Time Dependent Perturbation Theory (15 Hours)

The different pictures: The Schrodinger, The Heisenberg, The Interaction - Transition probability: Constant and Harmonic perturbation - adiabatic and sudden approximation - Transition rates: Absorption and Emission radiation, within the dipole approximation.

Teaching Methodology	Demo Videos, PPT, Handouts, Study materials

Books for Study

1. Zettile, N. (2009). *Quantum Mechanics: Concepts and Applications* (2nd Ed.). John Wiley & Sons.

Unit	Book	Chapters	Sections
I	1	3 & 4	3.1, 3.2, 3.3, 3.3.1, 3.3.2,3.4, 3.5, 3.5.1, 3.5.2, 3.5.3, 3.5.4, 3.6, 3.6.1, 3.6.2, 3.6.3, 3.6.4, 3.6.5, 3.8, 3.8.1, 3.8.2, 3.8.3, 4.2.1, 4.2.2, 4.2.3, 4.3, 4.4,
II	1	4 & 6	4.5, 4.5.1, 4.5.2, 4.5.3, 4.6.1, 4.6.2, 4.7, 4.7.1, 4.7.2, 4.8, 4.8.1, 4.8.2, 4.8.3, 6.2.1, 6.2.2, 6.3.1, 6.3.2, 6.3.5
III	1	5 & 7	5.1, 5.2, 5.3, 5.5, 5.6.1, 5.6.2, 5.6.3, 5.7, 5.7.1, 5. 7.3, 7.3.1, 7.3.2,
IV	1	9	9.1, 9.2, 9.2.1, 9.3, 9.4, 9.4.1, 9.4.2, 9.4.3, 9.4.4, 9.4.5
V	1	10	10.1, 10.2, 10.2.1, 10.2.2, 10.2.3, 10.3, 10.3.1, 10.3.2, 10.3.3, 10.4, 10.4.1, 10.4.2, 10.5.3, 10.5.4

Books for Reference

1. Shankar, R. (2014). *Principles of Quantum Mechanics* (2nd Ed.). Springer.
2. Feynman, R. (2012). *Feynman lectures on Physics - Vol 3* (new millennium edition), Pearson.
3. Merzbacher, E. (2011). Quantum *Mechanics*, (3rd Ed.). Wiley.
4. Bransden, B., & Joachain, C. (2004). *Quantum Mechanics* (2nd Ed.). Pearson.
5. Rogalski, M. S., & Palmer, S. B. (1999). *Quantum Physics*, (1st Ed.). CRC Press.
6. Leonard, I.S. (1968). *Quantum Mechanics*, (International student Edition), McGraw Hill.

Websites and eLearning Sources*

1. Visual quantum mechanics: https://vqm.uni-graz.at/
2. https://ocw.mit.edu/courses/physics/
3. https://epgp.inflibnet.ac.in/Home/ViewSubject?cat
4. https://nptel.ac.in/courses/115/106/115106066/

(* subject to availability - not to be used for exam purpose)

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K-Level)**
CO1	describe the principles and methods of wave mechanics and matrix mechanics based on Dirac notation.	**K1**
CO2	explain quantum mechanical methods to study angular momentum and various perturbed systems.	**K2**
CO3	apply the quantum theory to 1D potentials, 3D potentials, rotation & addition of angular momenta, stationary states and time-dependent systems.	**K3**
CO4	analyse various properties using the quantum theory and compare it with the results of classical physics.	**K4**
CO5	evaluate the methods and properties of various quantum mechanical systems.	**K5**
CO6	summarize the methods and properties of various quantum mechanical systems.	**K6**

Relationship Matrix										
Semester	**Course Code**	**Title of the Course**						**Hours**		**Credits**
2	**23PPH2CC03**	**Core Course - 3:** Quantum Mechanics						**5**		**5**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**				**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	2	2	1	3	3	2	2	2	**2.3**
CO2	3	3	2	2	1	3	3	2	2	2	**2.3**
CO3	3	3	2	2	1	3	3	2	2	2	**2.3**
CO4	3	3	2	2	1	3	3	2	2	2	**2.3**
CO5	3	3	2	2	2	3	3	2	2	2	**2.4**
CO6	3	3	2	2	2	3	3	2	2	2	**2.4**
										Mean Overall Score	**2.32 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
2	**23PPH2CC04**	**Core Course - 4:** Molecular Spectroscopy	**4**	**4**

Course Objectives
To know the basic concepts and methods in molecular spectroscopy.
To understand the theory behind various spectroscopic techniques.
To choose spectroscopic techniques based on the properties to be investigated.
To analyze and evaluate various spectra of molecules using different methods.
To predict the properties of molecules from the spectra by various techniques and solve chemical structures of molecules.

UNIT I: Microwave Spectroscopy **(12 Hours)**
Characterization of Electromagnetic Radiation - Quantization of energy - Regions of the Electromagnetic spectrum, width and Intensity of spectral lines - Rotation of Molecules, Rotational Spectra - A Diatomic Rigid Rotator - Intensity of Spectral lines - Effect of isotopic substitution.

UNIT II: Infra-Red Spectroscopy **(12 Hours)**
Vibrating diatomic molecule - Simple Harmonic Oscillator - anharmonic oscillator, diatomic vibrating rotator, vibrations of polyatomic molecules - fundamental vibrations and their symmetry - overtones and combination frequencies.

UNIT III: Raman Spectroscopy **(12 Hours)**
Introduction - Quantum theory of Raman effect - Classical theory of Raman effect - Pure rotational Raman spectra - Linear molecules, symmetry top molecules, asymmetric top molecules - vibrational Raman spectra - Raman activity of vibrations - rule of Mutual Exclusion.

UNIT IV: Electronic Spectroscopy of Molecules **(12 Hours)**
Born Oppenheimer approximation - vibrational coarsestructure, Frank-Condon Principle - Intensity of vibrational - electronic spectra - dissociation energy and dissociation products - Molecular photo-electron spectroscopy - X-ray photoelectron spectroscopy.

UNIT V: Spin Resonance Spectroscopy **(12 Hours)**
Spin and an applied field - nature of spinning particles - interaction between spin and a magnetic field - population of energy levels - the Larmor Precession - Fourier Transform Nuclear Magnetic Resonance spectroscopy - Electron-spin Resonance Spectroscopy - g factor - hyperfine structure due to electron - nucleus coupling - double resonance - techniques in ESR spectroscopy.

Teaching Methodology	Lectures, Demonstrations, Presentations and Videos

Book for Study

1. Banwell, C. N., & Mccash, E. M. (2014). *Fundamentals of molecular spectroscopy,* (4th Ed.). Tata McGraw-Hill Ltd.

Unit	Chapters	Sections
I	1,2	1.1, 1.2, 1.3, 1.7, 2.1, 2.2, 2.3-2.3.1, 2.3.2, 2.3.3
II	3	3.1-3.1.1, 3.1.3, 3.1.3, 3.2, 3.5-3.5.1, 3.5.2
III	4	4.1- 4.1.1, 4.1.2, 4.2-4.2.1, 4.2.2, 4.2.3, 4.2.3, 4.3-4.3.1, 4.3.2
IV	6	6.1-6.1.1, 6.1.2, 6.1.3, 6.1.4, 6.5-6.5.1, 6.5.2
V	7	7.1- 7.1.1, 7.1.2, 7.1.3, 7.1.4, 7.1, 7.5-7.5.1, 7.5.2, 7.5.3, 7.5.4, 7.5.6

Books for Reference

1. Aruldhas, G. (2014). *Molecular Structure and Spectroscopy,* (2nd Ed.). PHI Learning Private Ltd.
2. Svanberg, S. (2004). *Atomic and Molecular Spectroscopy,* (4th Ed.). Springer.

3. McHale, J. L. (2017). *Molecular Spectroscopy*, (2nd Ed.). CRC Press.
4. Straughan, B. P., & Walker, S. (1976). *Spectroscopy Volume 1-3*, Chapman & Hall Publishers.
5. Chatwal, G. R., & Anand, S. K. (2009). *Spectroscopy*. Himalaya Publishing House.

Websites and eLearning Sources*

1. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=+4mIqRALksfwQH9v8YSMrw==
2. https://swayam.gov.in/explorer?category=Physics
3. https://edu.rsc.org/resources/analysis
4. https://www.nist.gov/pml/molecular-microwave-spectral-databases
5. https://srdata.nist.gov/xps/Default.aspx

(* subject to availability - not to be used for exam purpose)

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K-Level)**
CO1	acquire knowledge of various spectroscopic methods such as MW, IR, Raman, Electronic and spin resonance spectra.	**K1**
CO2	explain the theory and understanding the techniques of molecular spectra.	**K2**
CO3	apply the principle of molecular and resonance spectra for solving various types of molecules.	**K3**
CO4	analyze and distinguish molecular rotational, vibrational, electronic spectra and chemical shift in different resonance spectra.	**K4**
CO5	evaluate and justify the molecular spectra based on rotation-vibration as well fine structure studies in electronic spectra.	**K5**
CO6	predict the properties of molecules from the spectra by various techniques and solve chemical structures of molecules.	**K6**

Relationship Matrix										
Semester	**Course Code**	**Title of the Course**						**Hours**		**Credits**
2	**23PPH2CC04**	**Core Course - 4:** Molecular Spectroscopy						**4**		**4**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**				**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	3	2	3	2	3	2	3	2	1	**2.3**
CO2	3	3	2	2	3	3	2	2	2	1	**2.3**
CO3	3	2	2	3	3	2	2	3	2	1	**2.3**
CO4	3	2	2	3	3	2	3	3	2	1	**2.4**
CO5	3	3	2	3	3	2	2	3	2	1	**2.3**
CO6	3	2	3	3	3	2	2	3	2	1	**2.3**
										Mean Overall Score	**2.31 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
2	**23PPH2CP02**	**Core Practical - 2:** Physics Practical - 2	**8**	**6**

Any 15 Experiments

1. Michelson Interferometer – wavelength, separation and thickness of thin sheet
2. Biprism – Optic bench - wavelength, separation and thickness of thin sheet
3. Energy Gap study of a semiconductor
4. Elastic Constants – Hyperbolic fringes
5. Laser: Magneto-striction, Faraday effect and Verdert constant of a given material
6. e-Millikan's oil drop method
7. Ultrasonic diffraction – velocity and compressibility in liquids
8. Determination of e/k using Ge and Si transistors
9. Permittivity of a liquid using RFO
10. Determination of phase transition temperatures of a binary liquid mixture at different concentrations
11. Polarizability of liquids
12. Fermi-Curie plot of the X-ray / Gamma ray spectrum and determination of end-point energy
13. Determination of transition temperature in liquid crystalline materials
14. Characteristics of laser and tunnel diode
15. Characteristics of LVDT
16. Characteristics of load cell
17. SCR – Characteristics and Applications
18. Study of regulated power supply – monolithic IC
19. Transmission Line Characteristics
20. Shift Registers using Flip-Flop & ICs
21. Design of ROM and RAM using diode / OR gate and flip flop
22. Design of Encoder and Decoder
23. Op-amp: Low, High and band pass Filters
24. Computational experiment: Curve fitting – Least square fitting
25. Computational experiment: Solving Schrodinger equation for hydrogen / LHO
26. Computational experiment: Op-Amp parameter study – Circuit simulation using Proteus
27. Computational experiment: Linear Harmonic Oscillator problem using Hamilton's equation
28. Determination of the wavelength of an unknown light source and the distance between the grooves of a compact disk.
29. Determination of band gap of a semiconductor sample using UV-VIS spectroscopy
30. Study of magnetic hysteresis in ferromagnetic materials

Semester	Course Code	Title of the Course	Hours/Week	Credits
2	23PPH2SP01A	**Self-paced Learning:** Medical Physics	-	2

Course Objectives
To recall the concepts of mechanics, thermodynamics, optics, acoustics and electromagnetism.
To understand the anatomy and physiological functions of human body.
To use the acoustical and imaging techniques and to measure pressures, temperature and blood velocity of the body.
To analyse medical reports.
To evaluate the physiological functions of the human body.
To combine the principles of physics and biology and to develop sustainable life.

UNIT I: Biomechanics

Motion in the Human machine - the standard human - material components of the body - bone - ligaments and tendons - cartilage - bone shortening - energy storage in tendons and long bones, muscles: skeletal muscles - the structure of muscles - passive muscles - activating muscles - the effect of exercise - levers - the elbow - the hip - the back - elasticity of bone, tissue, visco elasticity. pressures in the body: pressure in the cardiovascular system - hydrostatic pressure - bladder pressure - respiratory pressures - foot pressures - eye and ear pressures - biomechanical measurement - X-ray imaging technique.

UNIT II: Cardiovascular and Respiratory System

Cardiovascular System: circulatory system and cardiac cycle - physics of the circulation system: properties of blood - blood pressure and flow in vessels - capillaries and osmotic pressure - blood flow rates and speeds - consequences of clogged arteries - work done by the heart and the metabolic needs of the heart - blood velocity measurement - The Doppler effect - ECG, lungs and breathing: lungs - alveoli - breathing - volume of the lungs - breathing under usual and unusual conditions - work needed to breathe.

UNIT III: Heat and Energy Transfer in Human Body

Metabolism: energy, heat, work, and power of the body - conservation of energy and heat flow - energy content of body fuel - energy storage molecules - loss of body heat - body temperature - energy requirement - energy from food - regulation of body temperature - resistance to cold - diffusion through membranes thin-film flowmeters - thermistor flowmeters - thermal dilution - thermal conductivity methods - thermography.

UNIT IV: Bio-Acoustics and Bio-Optics

Acoustic Buzzer - voice filtering theory - parameters of voice - energetic speaking. auditory sensitivity - connections to hearing perceptions. structure of the eye - imaging and detection by the eye - transmission of light in the eye - the eye as a compound lens - accommodation ultrasonic imaging - theory and instrumentation.

UNIT V: Electrophysiology and Nuclear Medicine

Biological potentials - the nervous system - neural communication, the interface between ionic conductors: Nernst equation - membranes and nerve conduction - muscle action potentials - neural stimulation - tissue as a leaky dielectric - low-frequency effects: (0.1 Hz-100 kHz) - higher frequencies (>100 kHz) - physiological effects of electricity - electricity in bone. nuclear medicine - MRI - general principles - slice selection - phase encoding - frequency encoding - K space formalism, instrumentation: magnet design - magnetic field gradient coils - RF coils imaging sequences - imaging characteristics - contrast agents functional MRI, applications: brain, liver, skeletal and cardiac systems.

Teaching Methodology	Demo Videos, PPT, Handouts, Study materials

Books for Study

1. Herman, I.P. (2007). *Physics of Human Body*, (1st Ed.). Springer.
2. Davidovits, P. (2008). *Physics in Biology and Medicine*, (3rd Ed.). Elsevier.
3. Brown, B. H. (1999). *Medical Physics and Biomedical Engineering*, (1st Ed.). IOP Publishing.
4. Webb, A. G. (2003). *An Introduction to Biomedical Imaging*, (1st Ed.). Wiley.

Unit	Book	Chapters	Sections
	1	1, 4	1.2, 1.3, 4.1, 4.2.3, 4.2.4, 4.6, 4.7
I	2 3	1, 3, 8, 18 1, 2	1.1, 3.2, 3.8, 8.5, 8.11, 18.4 1.2, 2.2
	4	1	1.3-1.9
II	1	8	8.1, 8.2.1-8.2.6, 9.6
	3	19	19.7.1
	1	6	6.1-6.6
III	2	9, 11	9.6, 11.1, 11.2, 11.9,
	3	19	19.4
	1	10, 11	10.2, 10.3, 11.3.1-11.3.3
IV	2	15	15.7
	4	3	3.1, 3.4-3.8
	3	8, 16	8.2, 8.5, 8.6, 8.8.1, 16.1.1-16.1.5, 16.5
V	2	13	13.3
	4	4	4.1, 4.7, 4.10

Books for Reference

1. Maqbool, M. (2017). *An Introduction to Medical Physics.* Springer.
2. Jelinkova, H. (2013). *Lasers for Medical applications, diagnostics, therapy and surgery*, (1st Ed.)., Elsevier.
3. Khandpur, R. S. (2014). *Handbook of Biomedical Instrumentation,* (3rd Ed.). McGraw Hill.

Websites and eLearning Sources*

1. https://medicalphysics.duke.edu/about/what-is-medical-physics/
2. https://medicalphysics.duke.edu/about/what-is-medical-physics/
3. https://www.news-medical.net/health/The-Role-of-Physics-in-Medicine.aspx
   (* subject to availability – not to be used for exam purpose)

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K-Level)**
CO1	acquire knowledge about the mechanics of human body, the energy transfer in metabolism, the fluid dynamics of blood flow through vessels, the mechanisms for speaking, hearing, vision and neural communications.	**K1**
CO2	understand the anatomy and physiological functions of human body, medical imaging data in clinical use and	**K2**
CO3	apply physics principles, instrumental design, data acquisition strategies and imaging modalities in biomedical imaging.	**K3**
CO4	analyze physics concepts involved in human body and physiology.	**K4**
CO5	evaluate the physiological functions of the human body	**K5**
CO6	create the awareness of lab facilities for better medical treatment	**K6**

Relationship Matrix											
Semester	**Course Code**	**Title of the Course**							**Hours**		**Credits**
2	**23PPH2SP01A**	**Self-paced Learning:** Medical Physics							**-**		**2**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	2	3	2	2	2	2	2	2	3	**2.3**
CO2	3	2	2	2	3	2	2	3	2	2	**2.3**
CO3	2	2	2	2	2	3	2	2	2	2	**2.1**
CO4	3	3	3	2	3	2	2	2	2	3	**2.5**
CO5	2	2	3	2	3	3	2	2	2	2	**2.3**
CO6	3	2	2	2	3	2	2	3	2	2	**2.3**
										Mean Overall Score	**2.3 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
2	23PPH2SP01B	**Self-paced Learning:** Crystal Growth and Thin Films	-	2

Course Objectives
To recall the fundamental phases of matter and energy.
To understand the phase transitions, nucleation, growth and deposition.
To experiment various physico-chemical conditions to grow bulk crystals and to deposit films.
To categorize mechanisms involved in crystal growth and in thin film depositions.
To evaluate the growth techniques and to define crystallinity with their merits and challenges.
To modify the existing techniques and to build new techniques to harvest crystals and films with desired properties

UNIT I: Nucleation
Primary nucleation - Secondary nucleation - Solubility, super solubility and metastable zone - Crystal growth theories: surface energy theories, adsorption layer theories, kinematic theories, and diffusion reaction theories.

UNIT II: Crystal Growth from Melt and Vapour
Czochralski method - Bridgmann - Stockbarger method - Zone Melting Method - Vapour growth: direct vapour transport method, Chemical transport method.

UNIT III: Crystal Growth from Solution
Solution and Solubility - Choice of Solvent - Additives - Nucleation - Achievement of Supersaturation - Mason-Jar Method - Holden's Rotary Crystallizer - Temperature Differential Method - growth from silica gel - High temperature solution growth - Flux growth - Top seeded solution growth -Hydrothermal growth.

UNIT IV: Thin Film Deposition: Physical Vapour Deposition
Evaporation method: Vacuum evaporation, Electron beam evaporation - DC diode sputtering, Magnetron sputtering, Reactive ion sputtering, RF sputtering - Pulsed Laser Deposition - Molecular Beam Epitaxy.

UNIT V: Thin Film: Deposition Chemical Vapour Deposition and Liquid Phase Deposition
Chemical vapour deposition - typical chemical reactions - reaction kinetics - transport phenomena - CVD methods – Metal Organic Chemical Vapour Deposition - Plasma enhanced chemical vapour deposition - Langmuir-Blodgett films - Electrochemical deposition - Sol-gel films.

Teaching Methodology	Demo Videos, PPT, Handouts, Study materials

Books for Study

1. Mullin, W., & Butterworth-Heinemann, (2001). *Crystallization*, (4th Ed.). Oxford.
2. Bhat, H. L. (2015). *Introduction to crystal growth principles and practice.* CRC Press Taylor & Francis Group.
3. Frey, H., & Hamid, R. K. (2015). *Handbook of Thin-Film Technology*. Springer-Verlag Berlin Heidelberg.
4. Cao, G. (2006). *Nanostructures and nanomaterials: synthesis, properties and applications.* Imperial college press, Reprinted.

Unit	Book	Chapters	Sections
I	1	3, 5, 6	3.11, 3.12, 5.1, 5.2, 5.3, 6.1
II	2	8, 10	Relevant topics in page No. 124, 140, 155, 162, 242, 252
III	2	9	Relevant topics in page No. 183, 198, 207, 215
IV	3 2	3, 6, 9 11	3.5, 6.4, 6.6, 6.8, 6.9, 9.4 Relevant topics in page No. 262, 268
V	4 3	5 9	5.5, 5.5.1, 5.5.2, 5.5.3, 5.5.4, 5.9, 5.10, 5.11 9.4

Books for Reference

1. Santhana, P.R, & Ramasamy, P. (2000). *Crystal growth processes and methods.* Kru Publications.
2. Krishna, S. (2002). *Handbook of thin film deposition, processes and techniques,* (2nd Ed.). Noyes Publication.
3. Leon, I. M., & Glang, R (1970). *Handbook of Thin Film Technology*. McGraw Hill Higher Education.

Websites and eLearning Sources*

1. https://en.wikipedia.org/wiki/Thin_film#:~:text=A%20thin%20film%20is%20a,fundamental%20step%20in%20many%20applications.
2. https://www.engr.colostate.edu/ECE581/fall07/Two%20dimensional%20structures.pdf
3. https://iisc.ac.in/wp-content/uploads/2017/12/PH351.pdf
(* subject to availability – not to be used for exam purpose)

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K-Level)**
CO1	acquire the knowledge about the fundamentals of nucleation and various crystallization theories.	**K1**
CO2	understand various crystallization theories, various crystal growth methods and thin film deposition techniques.	**K2**
CO3	apply the essential processing parameters for different crystal growth and thin film deposition techniques.	**K3**
CO4	analyze the different growth techniques and choose an appropriate technique to grow crystals and thin films.	**K4**
CO5	evaluate the merits and demerits of different growth techniques	**K5**
CO6	design a new growth approach to overcome the existing demerits.	**K6**

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
2	**23PPH2SP01B**	**Self-paced Learning:** Crystal Growth and Thin Films	**-**	**2**

Course Outcomes	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	3	2	2	3	2	2	2	3	**2.5**
CO2	3	3	2	2	2	3	2	2	2	2	**2.2**
CO3	3	3	3	2	2	3	1	2	2	2	**2.3**
CO4	3	3	3	2	2	3	1	2	3	2	**2.4**
CO5	3	3	3	2	2	3	2	2	2	2	**2.4**
CO6	2	3	3	2	2	3	1	2	1	2	**2.1**
										Mean Overall Score	**2.23(High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
2	23PPH2SP01C	**Self-paced Learning:** Ultrasonics and its Applications	-	2

Course Objectives
To know the basics of Ultrasound and its transducers.
To understand the concepts of Ultrasonic measurement techniques.
To apply and realize the ultrasonic imaging in the sonochemistry.
To explore the importance of Non-destructive technique.
To compare various ultrasonic transducers.

UNIT I: Fundamentals of Ultrasonics
Introduction - Brief Early History - Underwater Sound (SONAR) - Medical and Biological Ultrasonics - Industrial Ultrasonics - Nondestructive Testing/Evaluation - Ultrasonics in Electronics - Physical Acoustics - Ultrasonic Systems: Transmitters and Receivers - Low- Intensity Applications - High-Intensity Applications - Modern Ultrasonics: An Interdisciplinary Field - Velocity of Sound in Solids - Velocity of Sound in Liquids - Velocity of Sound in Gases - Wave Incident on a Liquid - Solid Plane Interface, Semi-Infinite Media - Reflection, Refraction.

UNIT II: Basics of Ultrasonic Transducers
Piezoelectric Transducers - equivalent circuit of a simple piezoelectric transducer - efficiency of a simple piezoelectric transducer - maximum power transfer between Electronic Power Source and Simple Piezoelectric Transducers - Determining Transformation Factor (α) for the Piezoelectric Transducer Material - Quality Factor (Q) of Piezoelectric Transducers - Piezoelectric Transducers for High-Intensity Applications - Pulse-Type Transducers for Low-Intensity Applications Sensing - Piezoelectric Polymers for Transducers.

UNIT III: Measurement Techniques of Ultrasonics
Measurement of Velocity and Attenuation in Isotropic Solids - Measurement of Velocity and Attenuation in Fluids - Methods of Measuring Velocity of Sound - Interferometer Method - Resonance Method - "Sing-Around" Method - Pulse-Superposition Method - Pulse-Echo-Overlap Method - Measurements in Materials of High Attenuation - Measurements at High Temperatures - Measurements at High Pressures - Measuring Torsional Resonant Frequencies of Isotropic Bars.

UNIT IV: Applications of Ultrasonics
Electron Acoustic Image Converter - Schlieren Imaging - Liquid Levitation Imaging - Ultrasonic Imaging with Liquid Crystals - Photographic Methods of Imaging by Ultrasonics - Ultrasonic Holography - Acoustic Microscopy - Ultrasonic Arrays - Ultrasound in Process Industries - Monitoring Solidification (Interface Sensing) - Acoustic Time Domain Reflectometry - Three-Phase Reactors - Process Tomography Using Ultrasonic Methods - Ultrasonic Transducers. Process Industry Applications - Sonochemistry - Depolymerization - Polymerization – Precipitation - Metallurgical Effects.

UNIT V: Ultrasonic Non-Destructive Testing
Resonance Methods - Pulse Methods - Acoustic Emission Technique - Factors Affecting Resolution and Sensitivity - Near-Field Effects - Properties of the Materials - Eddy Sonic Inspection Method - Sonic Analysis - Acoustic Impact Technique - Ultrasonic Spectroscopy - Critical Angle Analysis - Instrumentation - Resonance Methods - Pulse Methods - Acoustic Emission Methods - Phased Arrays Systems - Methods Used to Determine Flaw Size.

Teaching Methodology	Demo Videos, PPT, Handouts, Study materials

Books for Study

1. Dale, E., & Bond, L.J. (2011). *Ultrasonics Fundamentals, Technologies and Applications*, (3rd Ed.). CRC Press, Taylor & Francis Group.

Unit	Book	Chapters	Sections
I	1	1,2	1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9, 1.10, 1.11, 1.12, 2.3.1, 2.3.2, 2.3.3
II	1	5	5.3, 5.3.1, 5.3.2, 5.3.3, 5.3.4, 5.3.5, 5.3.7, 5.3.8, 5.3.9, 5.4.2
III	1	6	6.2.1, 6.2.2, 6.3, 6.3.1, 6.3.2, 6.3.3, 6.3.4, 6.3.5, 6.3.6, 6.3.7
IV	1	10,11	10.2.2, 10.2.3, 10.2.4, 10.2.5, 10.2.6, 10.2.7, 10.2.8, 10.2.9, 10.3.1, 10.3.4, 10.3.5, 10.3.6, 10.3.7, 10.3.8, 11.4, 11.4.1, 11.4.2, 11.4.4, 11.5
V	1	7	7.2.1, 7.2.2, 7.2.3, 7.3, 7.3.1, 7.3.2, 7.4.1, 7.4.2, 7.4.3, 7.4.4, 7.4.5, 7.5, 7.5.2, 7.5.3, 7.5.4, 7.5.5, 7.5.7.2,

Book for Reference

1. David, J., & Cheeke, N. (2002). *Fundamentals and Applications of Ultrasonic Waves*, CRC Press.

Websites and eLearning Sources*

1. http://hyperphysics.phy-astr.gsu.edu/hbase/Sound/usound.html
2. https://www.sonotec.com/en/column/ultrasonic.html
3. https://www.britannica.com/science/ultrasonics

   (* subject to availability - not to be used for exam purpose)

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K-Level)**
CO1	acquire the knowledge of ultrasonic science and technology.	**K1**
CO2	understand the concepts of ultrasound, transducers and its working, measurements and applications.	**K2**
CO3	identify and apply fundamentals of ultrasound, transducers on different measurement techniques and applications of ultrasound.	**K3**
CO4	analyze and discuss basics and applications of ultrasound.	**K4**
CO5	evaluate ultrasonic based measurements, applications and nondestructive testing.	**K5**
CO6	design ultrasonic devices by applying the principles of ultrasound.	**K6**

Relationship Matrix											
Semester	**Course Code**	**Title of the Course**							**Hours**		**Credits**
2	**23PPH2SP01C**	**Self-paced Learning:** Ultrasonics and its Applications							-		**2**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	3	2	3	2	3	2	3	2	1	**2.3**
CO2	3	3	2	2	3	3	2	2	2	1	**2.3**
CO3	3	2	2	3	2	2	3	3	2	1	**2.3**
CO4	3	2	2	3	3	2	2	3	2	1	**2.3**
CO5	3	3	2	2	2	2	2	3	3	1	**2.3**
CO6	3	2	2	3	2	2	3	3	2	1	**2.3**
										Mean Overall Score	**2.3 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
2	23PPH2SP01D	**Self-paced Learning:** Forensic Physics	-	2

Course Objectives
To study the basic definitions and concepts involved in trace evidences.
To handle the evidences left out at the crime scene.
To Identify the Composition and Manufacture of Glass and Paint.
To Interpret of Physical aspects of Glass evidences.
To analyze the evidences with the help of various spectroscopic methods.

UNIT I: Trace Evidences
Preliminary definitions - Concepts and the production of physical evidence - Uses of trace evidence - The history of trace evidence - The scope of trace evidence - Associations based on physical pattern evidence - Associations based on material comparisons - The role of trace evidence databases - Complementary nature of trace evidence and DNA typing - Recognition and interpretation of trace evidence - Hair and fibre evidence - Glass evidence - Paint evidence - Miscellaneous types of trace evidence - Future Technology and trace evidence - Summary and conclusions.

UNIT II: Composition and Manufacture of Glass
Introduction - Definition of a glass - Commercial glass types - Glass-manufacturing process - Glass - forming processes - Secondary glass processing - Principal glass types and applications.

UNIT III: Interpretation of Physical aspects of Glass evidence
Glass as physical evidence - Recovery of evidence glass fragments - Physical matches of fractured glass - Fractures in flat glass - Fractures in other items - Glass fractures produced by fragments - Backward propagation of glass fragments - Glass in fires - Retention and persistence of glass fragments in clothing - Future directions for the physical examination of glass evidence.

UNIT IV: Interpretation of Paint Evidence
Introduction - Paint transfer mechanisms - Household paints - Vehicle paint - A Bayesian approach - Conclusion.

UNIT V: Elemental Analysis of Glass and Paint
Introduction - Forensic and analytical implications of the composition of glass - Atomic spectroscopy - X-ray methods - Introduction of Infrared spectroscopy - Infrared spectroscopy - Infrared instrumentation - Preparation of samples for analysis - Infrared analysis of paint - Interpretation of IR spectra of non-automotive (domestic) paints - Identification of automotive paints by interpretation of their infrared spectra. EDAX

Teaching Methodology	Demo Videos, PPT, Handouts, Study materials

Books for Study

1. Caddy, B. -Taylor & Francis Forensic science series (2001). *Forensic examination of Glass and Paint Analysis and interpretation,* Publication, London, United Kingdom.

Unit	Book	Chapters	Sections
I	1	1	1.1, 1.2, 1.3 1.4, 1.5, 1.6, 1.7, 1.8, 1.9, 1.10, 1.11, 1.12, 1.13, 1.14, 1.15, 1.16
II	1	2	2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7
III	1	6	6.1, 6.2, 6.3, 6.4, 6.5, 6.6, 6.7,6.8, 6.9, 6.10
IV	1	12	12.1, 12.2, 12.3, 12.4, 12.5, 12.6
V	1	4,10	4.1, 4.2, 4.3, 4.4, 10.1, 10.2, 10.3, 10.4, 10.5, 10.6, 10.7

Books for Reference

1. Richard, S., & Tiffany, R. (2020). *Criminalistics -An Introduction to Forensic Science*. Pearson - Education.
2. Hunter, H. (2014). *Solving Crimes with Physics*. Mason Crest publication.

Websites and eLearning Sources*

1. https://www.nist.gov/forensic-science#:~:text=Forensic%20science%20is%20the%20use,to%20anthropology%20and%20wildlife%20forensics.
2. https://www.merriam-webster.com/dictionary/forensic
3. https://nij.ojp.gov/topics/forensics

   (* subject to availability – not to be used for exam purpose)

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K-Level)**
CO1	acquire knowledge about the concept and scope of forensic evidences.	**K1**
CO2	understand the composition and manufacturing of different types of evidences.	**K2**
CO3	identify and apply physical aspects of various evidences.	**K3**
CO4	distinguish the different evidences with the help of spectroscopic analysis.	**K4**
CO5	measure the characterization of paint and glass fragments.	**K5**
CO6	integrate the principles and methods of glass and paint evidence.	**K6**

Relationship Matrix										
Semester	**Course Code**		**Title of the Course**					**Hours**		**Credits**
2	**23PPH2SP01D**		**Self-paced Learning:** Forensic Physics					**-**		**2**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**				**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	3	2	2	3	2	2	2	2	**2.4**
CO2	3	3	2	2	2	3	2	2	2	2	**2.3**
CO3	3	3	3	2	2	3	2	2	2	2	**2.4**
CO4	3	3	3	2	2	3	2	2	2	2	**2.4**
CO5	3	3	2	2	2	3	2	2	2	2	**2.3**
CO6	3	3	3	2	2	3	2	2	2	2	**2.4**
										Mean Overall Score	**2.36 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
2	23PPH2ES03A	**Elective - 3:** Mathematical Methods of Computational Physics and Python Programming	5	4

Course Objectives
To find the different computational techniques for physics applications.
To study the types of elements and symmetry operations and constructing the character tables based on the principles of the group theory.
To solve the differential equation using an appropriate numerical method and root finding methods Constructing a polynomial, like Newton Gregory method for equally spaced points.
To study the modules and structure of python programming.
To study and use the arrays, control structures using python programming.

UNIT I: Basics of Group Theory **(15 Hours)**

Definition and nomenclature - Rearrangement theorem - cyclic groups - subgroups - conjugate elements and class structure - identification of symmetry element and operations - molecular point groups.

UNIT II: Representation of C_n Groups **(15 Hours)**

The Great Orthogonality Theorem (Qualitative treatments) - character of representation. Character table - Generating symmetry operators - construction of character tables - irreducible representation for C_{2v} and C_{3v}.

UNIT III: Numerical Methods Applied to Physics Problems **(15 Hours)**

Numerical integration: Trapezoidal, Simpson's 1/3 rules - Truncation error - composite trapezoidal and Simpson's 1/3 rules. **ODE:** Fourth-order Runge-Kutta methods for first order ODE.

Interpolation: Newton's interpolation - Linear interpolation - Higher-order polynomials - Divided differences - Gregory - Newton forward and backward interpolation formulae - error in interpolation *(no theory and derivation of formulae in the entire unit)*

UNIT IV: Basics of Python **(15 Hours)**

Installing Python - Launch Python - Python modules - Python expression - objects and their methods - Lists - Tuples - Strings - Loops - Development Tools

UNIT V: Python Structure and Control **(15 Hours)**

SciPy and NumPy - arrays - array operations - scripts - contingent behavior - nesting – importing data - exporting data - visualizing data - Functions - random numbers and simulation - histograms and bar graphs -contour plots and surfaces - matrix library - Interpolation - Fourier Transform - Sparse eigenvalue problem.

Teaching Methodology	Demo Videos, PPT, Handouts, Study materials

Books for Study

1. Joshi, A.W. (2010). *Matrix and Tensors in Physics*. New Age Publications.
2. Tinkham, M. (1974). *Group Theory and Quantum Mechanics.* McGraw Hill Ltd.
3. Venkataraman, M.K. (2013*). Numerical Methods in Science & Engineering.* National Pub. Co. Madras.
4. Jesse, M.K., & Philip, N. (2015). *Python for Physical modelling.* Princeton University Press Princeton and Oxford.
5. https://docs.python.org/3/library/tk.html

Unit	Book	Chapters	Sections
I	1	1 & 2	1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9, 1.10, 1.11, 16.1, 16.2, 16.3, 16.4, 16.5, 16.6, 16.7, 16.8
II	2	1 & 2, 3, 5	1.1, 1.2, 2.1, 2.3, 2.4, 3.2, 3.3, 3.4, 5.2, 5.3, 5.4
III	3	1,3,7	All sections
IV	4	1, 2	1.2-1.4, 2.1, 2.2.1, 2.3, 2.4
V	4,5	2, 3, 5	2.2.2-2.2.10, 2.5-2.8, 3.1-3.3, 5.1-5.4

Books for Reference

1. Pipes, L. A. & Harvill, L. R (2014). *Applied Mathematics for Engineers and Physicists*, Dover Publications Inc.
2. Arfken, Weber, Harris. (2013). *Mathematical Methods for Physicists*, (7th Ed.). Academic Press.
3. Boas, M.I. (2006). *Mathematical Methods in the Physical Sciences*, (3rd Ed.). John Wiley & Sons.
4. Kreyszig E. (2015). *Advanced Engineering Mathematics*, (10th Ed.). Wiley.
5. Burden, R. L., & Faires, J. D. (2011). *Numerical Analysis*, (9th Ed.). Brooks/Cole Cengage Learning.
6. Chan, J. (2014). *Python for Beginners*.
7. Stewart, A. (2016). *Python Programming*.
8. *NumPy*-1.17 and *SciPy*-1.6.1 reference manual.

Websites and eLearning Sources*

1. https://ocw.mit.edu/courses/mathematics/
2. https://nptel.ac.in/courses/115/103/115103036/
3. https://epgp.inflibnet.ac.in/Home
4. https://swayam.gov.in/explorer
5. http://www.learncodingfast.com/python
6. https://www.tutorialspoint.com/python/index.htm
7. https://www.python.org/

   (* subject to availability - not to be used for exam purpose)

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K-Level)**
CO1	remember the: definition of groups, subgroups, Numerical Integration and python modules.	**K1**
CO2	understand the: important properties of group theory and its character tables, numerical integration and python structure.	**K2**
CO3	apply the ideas learnt in the above COs: involving operators and constructing the character tables and numerical interpolation and python functions.	**K3**
CO4	analyse the groups and subgroups, numerical integration and interpolation formulae applied to the physics problems and also using python programs.	**K4**
CO5	evaluate: the groups, numerical problems, Python expression, objects and their methods.	**K5**
CO6	create: the symmetry elements, numerical integration, array operations, scripts, histogram and bar graphs.	**K6**

Relationship Matrix											
Semester	**Course Code**	**Title of the Course**								**Hours**	**Credits**
2	**23PPH2ES03A**	**Elective - 3:** Mathematical Methods of Computational Physics and Python Programming								**5**	**4**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	2	2	2	2	3	2	3	1	1	**2.1**
CO2	3	3	2	2	2	3	3	2	1	1	**2.5**
CO3	3	2	3	2	3	2	2	2	3	3	**2.6**
CO4	3	3	2	2	2	3	3	2	1	2	**2.3**
CO5	2	3	3	2	3	2	2	2	3	3	**2.5**
CO6	3	3	2	2	2	3	3	2	1	2	**2.3**
										Mean Overall Score	**2.38(High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
2	23PPH2ES03B	**Elective - 3:** Physics of Disaster Management	5	4

Course Objectives
To impart fundamental knowledge of disasters.
To understand approaches of Disaster Management.
To develop the abilities required for responding to disasters.
To analyze the disaster phenomenon, its different contextual aspects, impacts and public health consequence.
To evaluate the various phases of disaster management of post disasters.

UNIT I: Disaster and its types **(15 Hours)**

Disaster Definition - Geographical Disaster – Flood - Draught, Cyclone - Earthquake - Landslide - Avalanches - Volcanic Eruptions - Climatic Disaster - Heat and Cold Wave - Climate Change - Global Warming - Sea level Rise - zone Depletion.

UNIT II: Manmade Disaster **(15 Hours)**

Manmade Disaster - Nuclear Disaster - Chemical Disaster - Biological Disaster - building Fire - Coal Fire - Oil Fire - Air Pollution - Water Pollution - Industrial Pollution – Deforestation - Rail & Road Accidents - Air & Sea Accidents.

UNIT III: Mitigation and Management techniques of Disaster **(15 Hours)**

Basic principles of disasters management - Disaster Management Cycle - Disaster management policy - National and State Bodies for Disaster Management - Early Warming Systems - building design and construction in highly seismic zones - retrofitting of buildings.

UNIT IV: Study of Important disasters **(15 Hours)**

Earthquakes and its types - magnitude and intensity - seismic zones of India - major fault systems of India plate - flood types and its management - drought types and its management - landside and its managements case studies of disasters in India - Social Economics and Environmental impact of disasters.

UNIT V: Disaster Response **(15 Hours)**

Institutional Arrangements for Disaster Response - Models of Risk Assessment and Disaster Response - Disaster Response in India - Managing and Funding Relief and Recover - Disaster Medicine - Disaster Site Management - Medical and Health Response to Different Disasters - Rehabilitation, Reconstruction and Recovery - Monitoring and Evaluation of Rehabilitation Work - Managing Relief Camps - Disaster Management in India.

Teaching Methodology	Demo Videos, PPT, Handout

Books for Study

Lecture Notes

Books for Reference

1. Copola, D.P. (2006). *Introduction to International Disaster Management* (1st Ed.). Butterworth Heineman.
2. Gupta, A.K., Nair, S.S., & & Chatterjee, S. (2013). *Disaster management and Risk Reduction, Role of Environmental Knowledge.* Narosa Publishing House, Delhi.
3. Murthy, D.B.N. (2012). *Disaster Management.* Deep and Deep Publication PVT. Ltd. New Delhi.
4. Modh, S. (2010). *Managing Natural Disasters*. Mac Millan publishers India LTD.

Websites and eLearning Sources*

1. https://youtu.be/gQxs2VJPf4o
2. https://youtu.be/v-NGndAd0T4
3. https://youtu.be/fZUrR8RA2pI

(* subject to availability - not to be used for exam purpose)

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K-Level)**
CO1	acquire knowledge on basic terms and concepts related to disaster and its management.	**K1**
CO2	understand the importance of disaster and its management.	**K2**
CO3	demonstrate various methods of risk reduction measures and risk mitigation.	**K3**
CO4	analyse the impacts of disasters and their assessment and remedies.	**K4**
CO5	create awareness about disaster prevention and risk reduction.	**K5**
CO6	acquire knowledge on basic terms and concepts related to disaster and its management.	**K6**

Relationship Matrix										
Semester	**Course Code**	**Title of the Course**						**Hours**		**Credits**
2	**23PPH2ES03B**	**Elective - 3:** Physics of Disaster Management						**5**		**4**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**				**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	2	2	3	2	3	2	3	2	2	**2.4**
CO2	3	2	3	2	2	2	2	2	3	2	**2.3**
CO3	2	2	2	2	3	3	2	3	2	2	**2.3**
CO4	3	2	2	3	2	3	3	2	3	2	**2.5**
CO5	2	3	2	3	2	2	3	2	2	2	**2.3**
CO6	3	2	2	3	2	3	2	3	2	2	**2.4**
										Mean Overall Score	**2.36(High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
2	23PSS2SE01	**Skill Enhancement Course:** Soft Skills	4	3

Course Objectives
To provide a focused training on soft skills for students in colleges for better job prospects
To communicate effectively and professionally
To help the students take active part in group dynamics
To familiarize students with numeracy skills for quick problem solving
To make the students appraise themselves and assess others

UNIT I: Effective Communication & Professional Communication (12 Hours)
Definition of communication, Barriers of Communication, Non-verbal Communication; Effective Communication - Conversation Techniques, Good manners and Etiquettes; Speech Preparations & Presentations; Professional Communication.

UNIT II: Resume Writing & Interview Skills (12 Hours)
Resume Writing: What is a résumé? Types of résumés, - Chronological, Functional and Mixed Resume, Purpose and Structure of a Resume, Model Resume.
Interview Skills: Types of Interviews, Preparation for an interview, Attire, Body Language, Common interview questions, Mock interviews & Practicum

UNIT III: Group Discussion & Personal effectiveness (12 Hours)
Basics of Group Discussion, Parameters of GD, Topics for Practice, Mock GD & Practicum & Team Building.
Personal Effectiveness: Self Discovery; Goal Setting with questionnaires & Exercises

UNIT IV: Numerical Ability (12 Hours)
Introducing concepts Average, Percentage; Profit and Loss, Simple Interest, Compound Interest; Time and Work, Pipes and Cisterns.

UNIT V: Test of Reasoning (12 Hours)
Introducing Verbal Reasoning: Series Completion, Analogy; Data Sufficiency, Assertion and Reasoning; and Logical Deduction. Non-Verbal Reasoning: Series; and Classification

Teaching Methodology	Chalk and talk, Lectures, Demonstrations, PPT.

Book for Study

1. Melchias G., Balaiah, J. & Joy, J. L. (Eds). (2018). *Winner in the Making: A Primer on soft Skills*. Trichy, India: St. Joseph's College.

Books for Reference

1. Aggarwal, R. S. (2010). *A Modern Approach to Verbal and Non-Verbal Reasoning.* S. Chand.
2. Covey, S. (2004). *7 Habits of Highly effective people.* Free Press.
3. Gerard, E. (1994). *The Skilled Helper* (5th Ed.). Brooks/Cole.
4. Khera, S. (2003). *You Can Win.* Macmillan Books.
5. Murphy, R. (1998). *Essential English Grammar*, (2nd Ed.). Cambridge University Press.
6. Sankaran, K., & Kumar, M. (2010). *Group Discussion and Public Speaking* (5th Ed.). M.I. Publications.
7. Trishna, K. S. (2012). *How to do well in GDs & Interviews*? (3rd Ed.). Pearson Education.
8. Yate, M. (2005). *Hiring the Best: A Manager's Guide to Effective Interviewing and Recruiting*

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K - Level)**
CO1	recall various soft skill sets	**K1**
CO2	understand personal effectiveness in any managerial positions	**K2**
CO3	apply verbal and non-verbal reasoning skills to solve problems	**K3**
CO4	differentiate problems at work and home; and design solutions to maintain work-life balance	**K4**
CO5	assess growth and sustainability and infuse creativity in employment that increases professional productivity	**K5**
CO6	construct plans and strategies to work for better human society	**K6**

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
2	**23PSS2SE01**	**Skill Enhancement Course:** Soft Skills	**4**	**3**

Course Outcomes	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	3	3	2	3	2	3	2	3	**2.7**
CO2	3	3	3	2	3	3	3	3	3	3	**2.9**
CO3	3	2	2	3	3	3	3	3	3	3	**2.8**
CO4	3	3	2	2	3	3	3	3	3	3	**2.8**
CO5	3	3	3	2	2	3	3	3	3	3	**2.8**
CO6	3	3	3	2	2	3	3	3	3	3	**2.8**
										Mean Overall Score	**2.8 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
3	23PPH3CC05	**Core Course - 5:** Electromagnetic Theory	5	5

Course Objectives
To acquire knowledge of vector operations in electric and magnetic fields, boundary conditions, wave propagation of EM waves in waveguides.
To understand the basics of Electrostatics and magnetostatics, to comprehend the physical ideas contained in Maxwell's equation, Coulomb & Lorentz gauges and conservation laws.
To solve boundary value problems, Gauss law problems in electrostatics, Ampere's law problems in magnetostatics.
To analyze the behaviour of EM waves in conducting surface through reflection, to deduce field equations, wave equations and Gauge transformations.
To estimate and interpret different laws in electrostatics and magnetostatics, scalar and vector potentials, energy and momentum of EM waves.

UNIT I: Electrostatics **(15 Hours)**

Coulomb's law - The electric field - Continuous charge distributions- Field lines, Flux and Gauss's law - The Divergence of E - Applications of Gauss's Law - The curl of E - Electric potential - Poisson's and Laplace Equation Potential of a localized charge distribution - Electrostatic Boundary conditions - Uniqueness theorems - Method of images: The classic image problem - induced surface charge -Force and energy - other image problems - boundary value problems on spherical symmetry, cylindrical symmetry and plane symmetry.

UNIT II: Magnetostatics **(15 Hours)**

The Lorentz Force Law - The Biot-Savart Law - The magnetic field of steady current - The Divergence and Curl of B - Applications of Ampere's Law - magnetic potential- from uniform surface current - of a long solenoid - toroidal coil - large parallel plate capacitor - magnetic field inside and outside a cylindrical wire - magnetic field inside and outside the slab Magnetic vector potential - magnetostatic boundary conditions.

UNIT III: Field Equations and Conservation Laws **(15 Hours)**

Ohm's law -Faraday's law - induced electric field - Inductance - Energy in magnetic fields - Maxwell's equations in free space and linear isotropic media - Boundary conditions on fields at interface- continuity equations - Poynting's theorem.

UNIT IV: Electromagnetic Waves **(15 Hours)**

Waves in one dimension - Reflection, transmission and polarization - The wave equation for E and B - monochromatic plane waves - Energy and momentum in EM waves - Propagation in linear media - Reflection and transmission at normal and oblique incidence.

UNIT V: Guided Waves, Potentials and Fields **(15 Hours)**

Wave guides -TE and TM waves in a rectangular wave guide -impossibility of TEM waves inwave guide - The coaxial transmission line- Scalar and Vector potentials - Gauge transformations- Coulomb Gauge and Lorentz Gauge - Lorentz force law in potential form - retarded potentials.

Teaching Methodology	Demo Videos, PPT, Handouts, Study materials, Problem Solving.

Book for Study

1. David, J. G. (2018). *Introduction to Electrodynamics*, (4th Ed.). Pearson.

Unit	Title	Chapters	Sections
I	Electrostatics	1,2,3	1.2 -1.4, 2.1 – 2.4, 3.1, 3.3 -3.5
	Potentials	1,2	1.5, 1.6, 2.1 -2.4

II	Magnetostatics	1,2,3,4	1.1 – 1.3, 2.1, 2.2, 3.1-3.3, 4.1, 4.2
III	Electrodynamics	1,2,3	1.1, 2.1 - 2.4, 3.3 – 3.6
	Conservation Laws	1	1.1, 1.2
IV	Electromagnetic Waves	1,2,3,4	1.1 – 1.4, 2.1 – 2.3, 3.1 – 3.3
V	Electromagnetic Waves	5	5.1-5.3
	Potentials and fields	1	1.1-1.4, 2.1

Books for Reference

1. Jackson, J. D. (1999). *Classical Electrodynamics,* (3rd Ed.). John Wiley.
2. Edward, C. J. & Keith, G. B. (2015). *Electromagnetic Waves and Radiating Systems,* (2nd Ed.). Prentice Hall of India.
3. Panofsky, W. & Phillips, M. (1962). *Classical Electricity and Magnetism.* Addison Wesley.
4. Kraus, J. D. & Fleisch, D. A. (1999). *Electromagnetics with Applications,* (5th Ed.). WCB McGraw-Hill.
5. Chakraborty, B. (2002). *Principles of Electrodynamics.* Books and Allied Pvt. Ltd.
6. Dr. Sureka Tomar. (2016). *CSIR – UGC / NET / JRF/SET Physical Sciences*. Upkar Prakashan.

Websites and eLearning Sources*

1. https://nptel.ac.in/courses/115/106/115106122/
2. https://.nptel.ac.in/courses/108/104/108104087/
3. https://.nptel.ac.in/courses/115/104/115104088/
4. https://ocw.mit.edu/courses/6-632-electromagnetic-wave-theory-spring-2003/
5. https://ocw.metu.edu.tr/course/view.php?id=226
6. https://ocw.metu.edu.tr/mod/resource/view.php?id=5135

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K-Level)**
CO1	remember and recall the relevant knowledge from Electrostatics, magnetostatics, EM equations and wave guide system.	**K1**
CO2	understand and comprehend the knowledge of Electrostatics and magnetostatics as well as EM waves with wave guide system.	**K2**
CO3	apply the principles of boundary conditions and EM field equations for finding the solutions in classic image problem, Maxwell’s equations in various conditions and wave guide system.	**K3**
CO4	analyze the image problems with various symmetries, as well as distinguish with various applications of EM waves and wave guide problems.	**K4**
CO5	estimate and interpret the applications of Gauss, Biot-Savarts, Ampere’s laws and magnetic vector potentials as well as EM field equations with free space and isotropic media.	**K5**
CO6	design of boundary value problems with various vectors. Also formulate the solutions of wave guide system with different applications.	**K6**

Relationship Matrix										
Semester	**Course Code**	**Title of the Course**							**Hours**	**Credits**
3	**23PPH3CC05**	**Core Course - 5:** Electromagnetic Theory							**5**	**5**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**				**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	2	3	3	2	3	2	3	2	2	**2.5**
CO2	2	3	2	2	2	3	2	2	3	2	**2.3**
CO3	3	2	2	3	2	3	3	2	1	2	**2.3**
CO4	3	2	2	2	2	3	3	2	1	2	**2.2**
CO5	3	3	2	2	2	3	3	3	1	2	**2.4**
CO6	2	3	2	2	2	3	3	3	1	2	**2.3**
										Mean Overall Score	**2.3 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
3	**23PPH3CC06**	**Core Course - 6:** Condensed Matter Physics	**4**	**4**

Course Objectives
To recall the fundamentals and models related to metals, semiconductor crystals in terms of energy gap and Bloch functions and to understand the superconducting materials and dielectric materials.
To interpret the behavior of semiconductor, metals, superconducting, magnetic, and dielectric materials based on classical and quantum mechanical approach.
To explain the concepts and phenomena associated with different materials.
To evaluate different parameters related to semiconductors, metals, superconducting, magnetic, and dielectric materials.
To plan for different materials for the benefit of the society.

UNIT I: Semiconductor Crystals **(12 Hours)**

Origin of energy gap - Bloch function – Kronig - Penney model - crystal momentum of an electron - number of orbitals in a band- Effective mass - intrinsic carrier concentration - intrinsic mobility - impurity conductivity - thermal ionization of donors and acceptors.

UNIT II: Fermi Surfaces and Metals **(12 Hours)**

Reduced zone scheme - periodic zone scheme - construction of fermi surfaces- nearly free electrons- electron orbits, hole orbits and open orbits - calculations of energy bands - Tight binding method for energy bands- Wigner - Seitz method - De Haas-van Alphen effect.

UNIT III: Super conductivity **(12 Hours)**

Thermodynamics of the superconducting transition - London equation - Coherence length -BCS theory of superconductivity - ground state - Flux quantization in a superconducting ring -Type II superconductors - vortex state - estimation of Hc1 and Hc2 - single particle tunnelling - Josephson superconductor tunnelling - Dc Josephson effect - Ac Josephson effect.

UNIT IV: Magnetic Properties of Solids **(12 Hours)**

Langevin diamagnetism equation - quantum theory of diamagnetism -Paramagnetism - quantum theory of Para magnetism - paramagnetic susceptibility of conduction electrons -ferromagnetic order - ferrimagnetic order - curie temperature and susceptibility of ferrimagnets -antiferro magnetic order - susceptibility below the Neel temperature - ferromagnetic domains - origin of domains -coercivity and hysteresis.

UNIT V: Polaritons, Polarons and Dielectrics **(12 Hours)**

Electrostatic screening - polaritons - electron - electron interaction - polarons - Polarization -macroscopic electric field - local electric field at an atom - dielectric constant and polarizability - structural phase transitions - displacive transitions.

Teaching Methodology	Demo Videos, PPT, Handouts, Study materials

Book for Study

1. Charles Kittel. (2004.). *Introduction to Solid State Physics*, (8th Ed.). John Wiley & Sons, Inc.

Books for Reference

1. Wahab, M. A. (2010). *Solid State Physics*, (2nd Ed.). Narosa.
2. Rita John. (2014). *Condensed Matter Physics*, (1st Ed.). Tata McGraw Hill Publishers.
3. J. P. Srivastava. (2015). *Elements of Solid-State Physics*, (4th Ed.). Prentice-Hall of India.

Websites and eLearning Sources*

1. https://nptel.ac.in/courses/115/106/115106061/
2. https://nptel.ac.in/courses/115/103/115103102/
3. https://nptel.ac.in/courses/115/105/115105099/
4. https://nptel.ac.in/courses/113/104/113104090/

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K-Level)**
	On successful completion of this course, students will be able to	
CO1	acquire knowledge about metals, semiconductor, superconducting, magnetic and dielectric materials.	**K1**
CO2	understand the formation of Brillouin zone and fermi surface in semiconductors, BCS theory, magnetic susceptibility and dielectrics.	**K2**
CO3	interpret the behavior of semiconducting, conducting, superconducting and dielectric materials based on classical and quantum theories.	**K3**
CO4	compare the properties of different materials.	**K4**
CO5	evaluate new materials behavior for specific requirement.	**K5**
CO6	plan to prepare different materials for the betterment of the society.	**K6**

Relationship Matrix										
Semester	**Course Code**	**Title of the Course**						**Hours**		**Credits**
3	**23PPH3CC06**	**Core Course - 6:** Condensed Matter Physics						**4**		**4**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**				**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	2	2	2	3	3	2	2	1	**2.3**
CO2	3	2	2	2	2	3	2	2	2	2	**2.2**
CO3	2	2	3	2	2	2	2	2	3	2	**2.2**
CO4	3	2	3	1	2	3	2	3	2	2	**2.3**
CO5	2	3	2	3	1	2	3	2	3	1	**2.3**
CO6	3	2	2	2	1	3	3	2	2	1	**2.3**
										Mean Overall Score	**2.26 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
3	23PPH3CC07	**Core Course - 7:** Fiber Optic Communication	4	4

Course Objectives
To identify the basic elements of optical fiber transmission link, fiber modes configurations and structures.
To classify the various optical sources, materials and fiber splicing.
To solve the various modes configurations and structures.
To categorize a fiber-optic communication system: transmitter, fiber, amplifier, and receiver.
To reframe the link budget, TDM and WDM network.
To design the optical communications link, including power, noise and rise time/jitter budgets.

UNIT I: Introduction to Optical Fibers (15 Hours)

Evolution of fiber optic system- Elements of an Optical Fiber Transmission link- Fiber Types- Rays and Modes - Step Indexed Fiber Structure - Graded Index Fiber Structure - Graded Index Numerical Aperture - Fiber losses.

UNIT II: Fiber Optical Sources and Couplers (15 Hours)

LED- LED materials - Fiber LED coupling - LASER - Spatial emission pattern of LASER - Modulation response of LASER - Single frequency LASER - Light emitting transistor. Optical Couplers: Types of optical couplers - Star couplers - T couplers - Source to fiber coupling efficiency - Opto-couplers and applications.

UNIT III: Analog and Digital Transmission System (15 Hours)

Overview of Analog Links - Multichannel Transmission Techniques - Multichannel Amplitude Modulation - Multichannel Frequency Modulation - Digital Transmission - Line Coding - NRZ codes - RZ Codes - Block Codes.

8UNIT IV: Coherent Optical Fiber Communication System (15 Hours)

Fundamental Concepts - Homodyne Detection - Heterodyne Detection - Modulation Techniques- Direct detection OOK - OOK Homodyne Detection - PSK Homodyne Detection - Heterodyne Detection Schemes - Polarization Control Requirements.

UNIT V: Network Systems and Techniques (15 Hours)

Wavelength Division Multiplexing - Local Area Networks - Optical Fiber Bus - Ring Topology - Star Architectures - Advanced Multiplexing Strategies - Optical TDM, Sub Carrier Multiplexing, WDM Network Architectures.

Teaching Methodology	Chalk & talk, Demo Videos, PPT, Study materials

Books for Study

1. Gerd Keiser. (1991). *Optical Fiber Communication*, (2nd Ed.). McGraw-Hill.
2. Subir Kumar Sarkar. (2010). *Optical Fiber and Fiber Optic Communication System*, (4th Ed.). S. Chand.

Unit	Book	Sections
I	1, 2	1.2, 1.3, 2.3.1, 2.3.2, 2.3.3, 2.6 & Chapter 7 respectively.
II	2	Chapter 9 & 12.
III	1	9.1,9.3, 9.3.1, 9.3.2, 8.2, 8.2.1-8.2.3
IV	1	10.1,10.3.1-10.3.4,10.4
V	1	11.1, 11.2.1-11.2.3

Books for Reference

1. Govind, P. A. (2002). *Fiber Optic Communication System*. John Wiley & Sons.
2. John Gowar. (2017). *Optical Communication System*. (2nd Ed.). Prentice Hall of India.

Websites and eLearning Sources*

1. https://www.phindia.com/Books/BookDetail/9789387472631/textbook-on-optical-fiber-communication-and-its-applications
2. https://link.springer.com/article/10.1007/s12043-001-0003-2

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K-Level)**
CO1	acquire the knowledge on the basic principle of optical fiber, sources, transmission system and networking techniques.	**K1**
CO2	understand the characteristics of optical fibers, theory of analog and digital transmission and network system.	**K2**
CO3	apply the fundamental principles of optics and light waves in optical fiber communication systems.	**K3**
CO4	analyze the working principle of fiber optical sources and different coupling schemes by an appropriate technique.	**K4**
CO5	evaluate the results by understanding the working principle of fiber optic communication and networking systems.	**K5**
CO6	design a point-to-point optical communications link, including power, noise and rise time/jitter budgets.	**K6**

Relationship Matrix										
Semester	**Course Code**	**Title of the Course**						**Hours**		**Credits**
3	**23PPH3CC07**	**Core Course - 7:** Fiber Optic Communication						**4**		**4**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**				**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	2	2	2	3	3	2	3	2	**2.5**
CO2	3	3	3	2	2	2	3	3	3	2	**2.6**
CO3	3	3	2	2	2	3	3	3	3	2	**2.6**
CO4	3	2	2	3	2	3	3	3	2	2	**2.5**
CO5	3	3	2	2	2	3	3	2	3	2	**2.5**
CO6	3	2	3	2	2	3	3	3	2	2	**2.5**
										Mean Overall Score	**2.53 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
3	**23PPH3CP03**	**Core Practical - 3:** Physics Practical - 3	**8**	**8**

Any 15 Experiments

1. e/m - Zeeman effect
2. Microwave – Klystron /Gunn diode
3. Design of Multiplexer and De-multiplexer
4. Digital to Analog Converters design
5. Design of Asynchronous Counter
6. Study of Power Amplifier: IC
7. Modulation and De modulation Techniques: PAM, PPM, PWM and PCM
8. Laser III: Brewster angle and related parameters
9. Geiger Muller Counter – study of gamma rays
10. Analysis of XRD spectrum - Determination of lattice parameters of a crystal
11. Analysis of FTIR spectrum - Determination of vibration levels in a compound
12. Solar cell characteristics
13. Charge of an electron by spectrometer
14. Monte Carlo simulation of electronic distribution of hydrogen atom - Scilab
15. Characteristics of tri colour LED and production of different colours
16. Measurement and analysis of Raman Spectra of liquids and solids.
17. Magneto resistance of a semiconductor
18. Thin film preparation and measurement of its thickness
19. Determination of Rydberg constant
20. Study of porosity and grain size of thin film by SEM
21. Brass arc spectrum – emission spectral study
22. UV-Visible spectrometer - Analysis of spectrum - Determination of absorption coefficient and bandgap
23. Analysis of rotation and vibration spectrum
24. Computational experiment: Solution of Poison’s equation
25. Computational experiment: 2-D Electrostatic Calculation
26. Computational experiment: Chaotic and Non-chaotic dynamics
27. Study characteristics of optocoupler
28. NMR SPECTROMETER – spectral parameters
29. Atomic Scattering power and geometrical structure factor
30. Non-Destructive Testing by Ultrasonics – flaw detection, depth and length

Semester	Course Code	Title of the Course	Hours/Week	Credits
3	23SPS3CC01	**Common Core:** Materials Science	5	4

Course Objectives
To know the basic concepts in materials science and characterization of materials.
To understand the structure and properties of various materials and the working of characterization techniques.
To choose materials based on characterization of properties for appropriate applications.
To analyze and evaluate various properties of materials.
To develop and suggest materials design for practical problems and applications.

UNIT I: Metal Alloys **(15 Hours)**

Elastic deformation– Stress-Strain Behavior- Anelasticity- Elastic properties- tensile properties- Hardness- Mechanism of strengthening in metals- Binary Phase diagrams- Phase transformation- microstructural and property changes in Iron-carbon alloy- types of metal alloys- fabrication - thermal processing of metals- Applications.

UNIT II: Ceramics **(15 Hours)**

Ceramic structure- crystal structure-silicate ceramics- Carbon-Ceramic Phase diagrams-mechanical properties- Stress-Strain Behavior -mechanics of Plastic deformation- types of ceramic-fabrication and processing of ceramics- glasses and glass-ceramics- clay- powder pressing-tape casting- 3D printing- Applications of ceramics.

UNIT III: Polymers Science **(15 Hours)**

Introduction to polymers- monomers- polymerization- types of polymerizations methods- Addition polymerization and condensation polymerization - Thermoplastics and thermos settings- classification of polymers - properties of polymers - molecular weight– viscosity-mechanical property - molecular weight relationships - number average and weight average molecular weight - optical property-Glass transition temperature - Applications of polymers.

UNIT IV: Material Characterization **(15 Hours)**

Principle and Instrumentation: X-Ray Photoelectron spectroscopy and Auger Electron spectroscopy- Scanning Tunneling Microscopy and Atomic Force Spectroscopy– X-Ray Diffraction- Transmission Electron Microscopy- Scanning Electron Microscopy - Infrared Spectroscopy and UV/Vis Spectroscopy -Macro and Micro Thermal Analyses.

UNIT V: Smart Materials **(15 Hours)**

Overview of Smart Materials - Structures and Products Technologies - Electrical properties - Piezoelectric Materials - Electro strictive Materials - Magneto strictive Materials - Magneto electric Materials - Magnetorheological Fluids - Electrorheological Fluids - Shape Memory Materials - Fiber-Optic Sensors - Smart Sensors: Accelerometers - Force Sensors - Load Cells - Torque Sensors - Pressure Sensors – Microphones - Impact Hammers - MEMS Sensors - Sensor Arrays Smart Actuators - Displacement Actuators - Force Actuators - Power Actuators - Vibration Dampers - Ultrasonic Transducers.

Teaching Methodology	Lectures, Demonstrations, Presentations and Videos.

Books for Study

1. Callister, Jr. W. D., & Rethwisch, D. G. (2018). *Materials Science and Engineering an Introduction*, (10th Ed.). Wiley.
2. Zhang, S., Li, L., & Kumar, A. (2008). *Materials Characterization Techniques*. CRC Press.
3. Gowariker, V. R., Viswanathan, N. V., & Sreedhar, J. (2005). *Polymer Science*. New Age International (P) Ltd.

4. Gandhi, M. V.,& Thompson, B. S. (1992). *Smart Materials and Structures*. Chapman & Hall.

Unit	Book	Chapters	Sections
I	1	6, 7, 9, 10, 11	6.3-6.10, 7.8-7.10, 9.7, 10.2-10.9, 11.1-11.10
II	1	12, 13	12.2-12.10, 13.2-13.10,13.11-13.15
III	2	1,2,3 &6	1.1-1.4, 2.1 – 2.5, 3.1 – 3.7, 6.1 – 6.10
IV	3	3,4,5,7,9 & 10	3.3,3.4,4.2,4.3,5.1 -5.6 ,7.1,7.2,7.2,9.1.4,9.2,10.1,10.3
V	4	1,2,13	1.1-1.10,2.1-2.12,13.8 – 13.15

Books for Reference

1. Billmeyer, F. W. (1994). *Textbook of Polymer Science*, (3rd Ed.). John Wiley.
2. Lee, J. D. (2008). *Concise Inorganic Chemistry*, (5th Ed.). Wiley Blackwell Publications.
3. Sze, S. M. (2007). *Physics of Semiconductor Devices*. Wiley-Inter Science.

Websites and eLearning Sources*

1. https://www.britannica.com/technology/materialsscience#:~:text=materials%20science%2C%20the%20study%20of,a%20material's%20composition%20and%20structure.
2. https://www.annualreviews.org/doi/pdf/10.1146/annurev.ms.24.080194.000245#:~:text=This%20is%20the%20same%20set,composition%2C%20properties%2C%20and%20performance.
3. https://www.coursera.org/learn/materials-science

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K-Level)**
CO1	know the various types of materials, their applications and characterization techniques.	**K1**
CO2	understand the structure and properties of various materials and the working of various characterization methods.	**K2**
CO3	identify and choose materials based on properties characterized by various methods.	**K3**
CO4	analyze and investigate the properties and characteristics of materials using various techniques.	**K4**
CO5	evaluate and interpret the features of the materials for appropriate applications.	**K5**
CO6	develop and modify materials design to address various problems	**K6**

Relationship Matrix										
Semester	**Course Code**	**Title of the Course**							**Hours**	**Credits**
3	**23SPS3CC01**	**Common Core:** Materials Science							**5**	**4**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**				**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	2	2	3	2	3	2	3	2	1	**2.3**
CO2	2	3	2	2	3	3	2	2	2	1	**2.2**
CO3	3	3	2	3	3	2	3	2	2	1	**2.4**
CO4	3	2	2	3	3	2	2	3	2	1	**2.3**
CO5	3	3	2	2	2	2	2	2	2	1	**2.1**
CO6	2	2	2	2	3	3	2	3	2	1	**2.2**
										Mean Overall Score	**2.25 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
4	23PPH4CC08	**Core Course - 8:** Nuclear and Particle Physics	**6**	**6**

Course Objectives
To acquire the knowledge of various nuclear decays and radioactivity.
To understand the basic structure, properties of nucleus and deuteron, Cosmic rays and Radio astronomy, symmetry properties & Quark model of elementary particles
To evaluate the different types of nuclear reactions.
To apply the knowledge of nuclear reactions for producing fission and fusion energy.
To analyse the properties of various fundamental particles, their decay modes and the interactions.

UNIT I: Basic Properties of Nucleus (18 Hours)

Nuclear mass and binding energy - atomic masses - systematics of nuclear binding energy -nuclear size - charge radius - potential radius - spin and parity - statistics of nucleus - magnetic dipole moment - electric moments - electric quadrupole moments - isospin - nuclear forces - ground state of the deuteron - wave equation for the deuteron and solution - excited state of deuteron - low energy proton neutron scattering - spin dependence of n-p interaction. Liquid Drop Model - Evidence of Shell Structure – Single Particle Shell Model.

UNIT II: Nuclear Decay and Radio Activity (18 Hours)

Theory of alpha disintegration - hindrance and formation factors - fine structure of alpha decay - energetics of beta decay - neutrino hypothesis - Fermi theory of beta decay - selection rules -Sargent diagram - orbital electron capture - parity non-conservation - double beta decay - gamma ray spectra and nuclear energy level - radioactive transition in nuclei-nuclear isomerism - internal conversion-resonance fluorescence -angular correlation.

UNIT III: Nuclear Reactions (18 Hours)

Types of nuclear reactions - conservation laws - reaction energetics - Q value - threshold energy - nuclear reaction cross section - level width - compound nuclear theory - Breit Wigner dispersion formula and interpretation - direct reaction - striping and pickup reactions - nuclear fission - energy released in fission - nuclear chain reaction - four factor formula - nuclear reactor - nuclear fusion Stellar energy.

UNIT IV: Particle Physics (18 Hours)

Production of new particles in high energy reaction - classification of elementary particle - fundamental interaction - quantum numbers - antiparticles - resonances - law in production and decay process - symmetry and conservation laws - special symmetric groups - Gelman -Neumann theory - Quark model - SU(3) symmetry - unification of fundamental interactions - CPT invariance and applications of symmetry arguments to particle reaction, parity non conservation in week interaction.

UNIT V: Cosmic Rays and Applications of Nuclear Physics (18 Hours)

Nature of Cosmic rays - soft and hard components - instruments and apparatus used in research of cosmic rays - absorption of cosmic ray - discovery of positron - cosmic ray shower discovery of muons - properties of ì - meson - discovery of Pi meson - Trace Element Analysis - Diagnostic Nuclear Medicine - Therapeutic Nuclear Medicine.

Teaching Methodology	Demo Videos, PPT, Handouts, Study materials.

Books for Study

1. Ghoshal. S. N. (2003). *Nuclear Physics*. S. Chand and company Ltd.,
2. Satya Prakash. (2014). *Nuclear Physics and Particle Physics*, (1st Ed.). Sultan Chand and sons.
3. Kakani, S. L., & Shubhrakakani (2013), *Nuclear Particle and Physics*, (2nd Ed.). Vivo books (private) Ltd.
4. Kenneth, S. K. (1988). *Introductory Nuclear Physics*, (3rd Ed.). John Wiley and Sons.

Unit	Book	Chapters	Sections
I	1	2,17	2.1, 2.13, 17.2, 17.3, 17.4, 17.6, 17.8
II	1	4,5,6	4.9-4.12,5.5-5.7,5.9,5.10,5.12,5.16,5.18,6.8-6.11,6.16, 6.19
III	2	8,9	8.1,8.2,8.4,8.5,8.7,8.10,8.12,8.13,8.15,8.16,9.2,9.4, 9.11, 9.12, 9.13, 9.17, 9.21
IV	2	11	11.4-11.14,11.15, 11.16
V	3 4	10,20	10.3,10.4, 10.7-10.12, 10.14 20.1, 20.4, 20.5

Books for Reference

1. Pandya., & Yadav. (2004). *Nuclear and Particle Physics world*. Cambridge University Press.
2. Bernard, L. C. (2002). *Concepts of Nuclear Physics*. Tata McGraw Hill Publishing Co.
3. Kaplan, I. (2001). *Nuclear Physics*, (2nd Ed.). Addison-Wesley Pub. Co.

Websites and eLearning Sources*

1. https://phys.libretexts.org/Bookshelves/Nuclear_and_Particle_Physics
2. https://www.britannica.com/science/physics-science/Nuclear-physics
3. https://onlinecourses.nptel.ac.in/noc22_ph41/preview

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K-Level)**
CO1	recall and explain a clear picture of nuclear composition, Radio activity, cosmic rays and understand various nuclear models.	**K1**
CO2	understand the working of nuclear detectors and counters, realize the importance of Cosmic rays and its effects on earth.	**K2**
CO3	apply and evaluate the applications of Nuclear Physics to Medical field and various other fields related to Physics.	**K3**
CO4	analyse the different types of nuclear particles and particle accelerators.	**K4**
CO5	formulate the four-factor formula and compound nuclear theory based on nuclear fission and fusion concepts.	**K5**
CO6	summarize the properties of various fundamental particles, their decay modes and the interactions.	**K6**

Relationship Matrix										
Semester	**Course Code**	**Title of the Course**						**Hours**		**Credits**
4	**23PPH4CC08**	**Core Course - 8:** Nuclear and Particle Physics						**6**		**6**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**				**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	2	3	2	2	3	3	2	2	2	**2.4**
CO2	2	2	3	2	2	3	2	2	2	2	**2.2**
CO3	3	2	2	2	2	2	2	3	2	2	**2.2**
CO4	3	3	2	2	2	2	3	2	2	2	**2.3**
CO5	2	2	2	2	2	3	2	2	2	2	**2.1**
CO6	3	3	2	2	2	2	3	2	2	2	**2.3**
										Mean Overall Score	**2.25 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
4	**23PPH4CC09**	**Core Course - 9:** Statistical Mechanics and Thermodynamics	**5**	**5**

Course Objectives
To know the relationship between the microscopic view to the macroscopic view of matter and develop tools for characterizing bulk matter at the macroscopic level.
To describe the laws of thermodynamics and how they regulate macroscopic physical process.
To establish the general laws and applications of thermodynamics and introduce the classical and quantum statistical mechanics.
To demonstrate postulates of statistical mechanics and develop the quantum statistical mechanics which is part of the foundation of several branches of Physics and has many applications.
To analyze the physics of phase transition and employ the concepts for its applications and to introduce the Boltzmann transport and transport properties and fluctuations in the various system.

UNIT I: Fundamentals of Statistical Mechanics **(15 Hours)**

Objectives of statistical Mechanics - Concept of Entropy and disorder - Thermodynamic potentials and reciprocity relations - chemical potential - description of systems of particles system - phase space - volume in phase space - concept of ensembles - micro canonical - canonical - grand canonical - Liouville's theorem - Statistical, thermal, mechanical and particle equilibrium.

UNIT II: Classical Statistical Mechanics **(15 Hours)**

Micro and Macro states - classical Maxwell - Boltzmann distribution law - distribution of velocities - principle of equipartition of energy - connection between the partition function and thermodynamic quantities - mean values obtained from distribution law - Boltzmann's entropy relation - perfect gas in micro canonical ensemble - Comparison of ensembles.

Unit III: Quantum Statistical Mechanics **(15 Hours)**

Statistical weight - density matrix - Bose - Einstein - Fermi-Dirac - Maxwell - Boltzmann Statistics - black body radiation and Planck's radiation law - Thermodynamic behavior of ideal Bose and Fermi gas - Bose-Einstein condensation - Liquid Helium - Super fluidity - Tisza's two Fluid model - electron gas of metals - Free electron model and electronic emission.

Unit IV: Transport Properties and Fluctuation **(15 Hours)**

Boltzmann transport equations - Boltzmann transport equations for electrons and Lorentz solution - chambers equation - thermal conductivity of metals - mean square deviation - fluctuations in energy, Probability of one-dimensional random walk - Brownian movement - Fokker Planck equation - Nyquist's theorem.

Unit V: Phase Transitions And Its Models **(15 Hours)**

Phase transitions - first and second kind - critical exponent - YANG and LEE theory - phase transition of second kind - Ising model: Bragg-William's approximation - one dimensional model - adiabatic de-magnetisation.

Teaching Methodology	PPT, Handouts, Study materials.

Book for Study

1. Gupta, S. L & Kumar, V. (2009). *Statistical Mechanics*, (23rd Ed.). Pragati Prakashan.

Unit	Book	Chapters	Sections
I	1	1	1-3, 7, 1.1, 1.1-1, 1.3, 1.7, 1.9, 1.10-1.13
II	1	2,3	2.1, 2.7, 2.10, 2.12, 2.14, 2.15, 2.16, 3.0-2
III	1	5,6,8 & 9	5.8, 5.10, 6.2-6.4, 6.10, 8.0, 8.2, 9.0, 8.4, 8.4-1, 9.3
IV	1	10,12	10.1, 10.2, 10.3, 10.5, 12.1, 12.5, 12.6, 12.10
V	1	13	13.1-13.7

Books for Reference

1. Prakash, S., & Agarwal, J. P. (2002). *Statistical Mechanics*. Pragati Prakahan.
2. Agarwal, B. K., & Melvin Eisner. (2013). *Statistical Mechanics*, (3rd Edition). New Age International (P)ltd.
3. Tomar, S. (2017). CSIR-*UGC NET/JRF/SET Physical Sciences*, (3rd Ed.). (for problems).

Websites and eLearning Sources*

1. https://github.com/peastman/statmech.
2. https://www.damtp.cam.ac.uk/user/tong/statphys.html
3. https://link.springer.com/book
4. https://www.sciencedirect.com/topics/chemistry/statistical-mechanics
5. https://en.wikipedia.org/wiki/Statistical_mechanics

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K-Level)**
CO1	acquire the knowledge of different laws of thermodynamics.	**K1**
CO2	understand about diverse thermodynamic potentials and their importance to deduce reciprocity relations and Bragg-Williams approximation.	**K2**
CO3	apply the Knowledge about Liouville's theorem and its importance of MB distribution law, BE and FD distribution law.	**K3**
CO4	analyze the statistical laws to study transport phenomena.	**K4**
CO5	evaluate the probability of distribution of particle in different quantum states based on Bose-Einstein, Fermi-Dirac, Maxwell-Boltzmann statistics.	**K5**
CO6	creating the solutions for different microstate problems based on different statistical theories.	**K6**

Relationship Matrix										
Semester	**Course Code**	**Title of the Course**							**Hours**	**Credits**
4	**23PPH4CC09**	**Core Course - 9:** Statistical Mechanics and Thermodynamics							**5**	**5**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**				**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	2	3	3	2	3	2	3	2	2	**2.5**
CO2	2	3	2	2	2	3	2	2	3	2	**2.3**
CO3	3	2	2	3	2	3	3	2	1	2	**2.3**
CO4	2	2	2	2	2	3	3	2	1	2	**2.1**
CO5	2	2	2	2	2	3	3	2	1	2	**2.1**
CO6	2	3	2	2	3	3	3	3	1	2	**2.4**
										Mean Overall Score	**2.28 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
4	**23PPH4CP04**	**Core Practical - 4:** Physics Practical - 4	**8**	**6**

Any 15 Experiments

1. AlO Band – spectral parameters
2. Laser IV: Fiber Optics cable parameters
3. Op-amp: Solving I order Simultaneous Equation
4. Analog to Digital Converter design
5. Design of Synchronous Counter
6. Digital Modulation: ASK, FSK and PSK
7. Four Probe and two probe Method
8. Optical constants of dielectric and metal films
9. Electron Spin Resonance Spectrometer
10. Determination of Fermi energy of copper
11. Measurement of radiant flux density and luminous intensity of emission source
12. Surface morphological characterization of nanomaterial by TEM
13. Jamin's interferometer - refractive index of air
14. Measurement of thermoelectric power
15. Computation through Origin: Mathematical functions
16. Computation through Origin: Curve Fitting
17. Computational experiment: Origin - Signal processing
18. Basic programs – Arduino
19. Frequency and humidity measurement - Arduino
20. Light intensity and distance measurement - Arduino
21. Pressure and density measurement - Arduino
22. Density and viscosity measurement - Arduino
23. Design of LCR meter - Arduino
24. Measurement and control of temperature - Arduino
25. Weather and astronomy related image processing using Python
26. Fast Fourier Transform using Python
27. Sound measurement – Arduino
28. Ellipsometer – Determination of n and k of a material
29. Design of MOSFET power inverter
30. Hydrogen Spectrum and Rydberg Constant

Semester	Course Code	Title of the Course	Hours/Week	Credits
4	23PPH4ES03A	**Elective - 4:** Microcontroller Based Physics Instrumentation	5	4

Course Objectives
To describe the fundamentals of microcontroller, Arduino, IoT.
To provide the knowledge on the features of Arduino and understand its functions.
To discover Arduino and IoT circuits for physics applications.
To experiment the interfacing between microcontroller and sensors/actuator for Roll-to-Roll system.
To recommend microcontroller circuit for domestic and industrial applications and design the Arduino based physics instruments.

UNIT I: Microcontroller and Architecture of Arduino **(15 Hours)**

Microprocessor and Microcontroller - ATmega328/P: Introduction - Feature - Description - Block Diagram - Pin Configurations - Pin Descriptions.**Arduino:** Block diagram - Architecture - Pin functions - features - I/O Ports - Timers - interrupts - serial port - variants - Introduction to Arduino IDE - writing, saving, compiling and uploading sketches.

UNIT II: Arduino Language Reference and Programming **(15 Hours)**

Language Reference: Variables - Operators - Control structures - Time and math functions Libraries and library management - Board management - digital I/O: blinking LED - interfacing Switch and 4x4 matrix keyboard - Interfacing LCD - simple programs.

UNIT III: Programing Arduino Peripherals **(15 Hours)**

ADC – Analog Read – Analog Reference - Pulse Width Modulation PWM - control of DC motor - Serial Communication - Inter Integrated Circuit I2C- Serial Peripheral Interface SPI- Ethernet shield.

UNIT IV: Microcontroller Instrument Design **(15 Hours)**

Pressure meter - thermometer - lux meter - Ultrasonic range finder - humidity meter - density meter - viscometer - dielectric meter - LCR meter

UNIT V: Internet of Things (IoT) **(15 Hours)**

Introduction - Block diagram - Networking with ESP8266 Wi-Fi module - MQTT Protocol - IoT service platform - IoT weather monitoring - IoT Physics Applications - IoT based air pollution meter.

Teaching Methodology	PPT, Handouts, demonstration videos, animations, Circuit Simulation, Arduino IDE and projects designs.

Books for Study

1. Atmega328/P Data sheet.
2. Evans, B. (2011). *Beginning Arduino Programing*. A press.
3. Waher, P. (2015). *Learning Internet of Things*. Packt Publishing.

UNIT	BOOK	CHAPTERS	SECTIONS
I	1 2	1, 2, 4, 5, 11 & 12.1	1, 2, 4, 5, 11 & 12 1
II	2	2, 3, 4, & 5	2, 3, 4, & 5
III	2	6, 7 & 10	6, 7 & 10
IV	2		Programs
V	3	1, 2, 5, & 7	1, 2, 5, & 7

Books for Reference

1. Simon Monk. (2016). *Programming Arduino, Getting Started with Sketches*, (2nd Ed.). McGraw-Hill Education.

Websites and eLearning Sources*

1. https://www.arduino.cc/
2. https://www.arduino.cc/en/Tutorial/HomePage
3. https://opensource.com/resources/what-arduino

Course Outcomes		
CO No.	CO-Statements On successful completion of this course, students will be able to	Cognitive Levels (K-Level)
CO1	describe the architecture of Microcontroller, Arduino and IoT.	**K1**
CO2	outline the features of Arduino IDE, syntax and algorithm and understand the use of this to solve the problems.	**K2**
CO3	identify the applications of Arduino, recommend the methods, design and construct various physics Instruments.	**K3**
CO4	examine the problems encountered in interfacing the Arduino with the accessories to analyse the problems	**K4**
CO5	recommend Arduino circuits for the applications and use professional ethics on using sensors to rate modern society.	**K5**
CO6	design the automatic electronic devices and plan develop an instrument having self-sustainability, employability and over all Personality	**K6**

Relationship Matrix										
Semester	**Course Code**	**Title of the Course**							**Hours**	**Credits**
4	**23PPH4ES03A**	**Elective - 4:** Microcontroller Based Physics Instrumentation							**5**	**4**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**				**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	2	2	2	3	3	3	3	2	**2.6**
CO2	3	3	3	2	2	3	3	3	3	2	**2.7**
CO3	3	3	3	2	2	3	3	3	3	2	**2.7**
CO4	3	3	2	3	2	3	3	3	3	2	**2.7**
CO5	3	3	3	3	2	3	3	3	2	2	**2.7**
CO6	3	3	3	3	2	3	3	3	2	2	**2.7**
										Mean Overall Score	**2.68 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
4	**23PPH4ES03B**	**Elective - 4:** Physics of Sensors and Transducers	**5**	**4**

Course Objectives
To introduce the fundamentals of sensors and transducers.
To provide the knowledge on the features of sensors and transducers and their principles.
To demonstrate the principles of sensors and their corresponding functions.
To analyze the working of electronic instruments and interfacing the sensors/actuator in electronic system.
To decide the sensors for a specific application and develop the transducers for various applications.

UNIT I: Data Acquisition and Sensors **(15 Hours)**
Sensors, Signals, and Systems - Sensor Classification - Mathematical models - Calibration - Computation of parameters - mobile communication sensors - Span - Full-Scale Output - Calibration Error - Hysteresis - Nonlinearity - Saturation - Repeatability - Dead - Resolution - Special Properties - Dynamic Characteristics – Uncertainty.

UNIT II: Physics Principles of Sensing **(15 Hours)**
Capacitance - Magnetism - Induction - Resistance - Piezoelectric Effect - Pyroelectric Effect - Hall Effect - Thermoelectric Effects - Temperature and Thermal Properties of Materials - Heat Transfer.

UNIT III: Physics of Detectors **(15 Hours)**
Ultrasonic Detectors - Microwave Motion Detectors - Linear Optical Sensors - Optoelectronic Motion Detectors - Optical Presence Sensors - Pressure-Gradient Sensors - Gesture Sensing - Tactile Sensors.

UNIT IV: Transducers I (Principle and Design) **(15 Hours)**
Metal detector - Magneto strictive detector - proximity detector - ablation transducer - cryogenic liquid level transducer - Tachometer - laser gyroscope - Inclinometer - Seismic transducer - piezoelectric accelerometer - pressure sensitive film - vacuum pressure gauge - ultrasonic flow transducer.

UNIT V: Transducers II (Principle and Design) **(15 Hours)**
Condenser microphone - optical microphone - optical hygrometer - oscillating hygrometer - soil moisture - image detector - UV detector - thermal radiation detector - Ionization detector - ceramic PTC transducer - chemical transducer - biological transducer.

Teaching Methodology	PPT, videos, demonstration, circuit simulation, and projects designs.

Book for Study

1. Fraden, J. (2016). *Handbook of Modern Sensors - Physics, Designs, and Applications*, (5th Ed.). Springer.

UNIT	BOOK	CHAPTERS	SECTIONS
I	1	1, 2, 3	1.1, 1.2, 2.1-2.3, 3.1-3.3, 3.5-3.12, 3.16, 3.21
II	1	4	4.2-4.9, 4.11, 4.12.
III	1	7	7.1, 7.2, 7.5, 7.8-7.13
IV	1	8, 9, 10	8.4.5, 8.4.8, 8.5.2, 8.6.1, 9.1.2, 9.2.3, 9.3.2, 9.3.3, 9.3.6, 10.3, 11.10, 12.4
V	1	13, 14, 15, 16, 17, 18	13.3, 13.5, 14.6-14.8, 15.6-15.8, 16.2, 17.4.5, 18.1-18.4, 18.9

Books for Reference

1. Michael Stanley & Jongmin Lee. (2018). *Sensor Analysis*. Morgan & Laypool publishers.

Websites and eLearning Sources*

1. https://www.nap.edu/read/4782/chapter/4
2. https://www-physics.lbl.gov/~spieler/TSI-2007/PDF/Sensor_Physics_I.pdf
3. https://www.elprocus.com/tilt-sensor-types-working-principle-and-its-applications/

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K-Level)**
CO1	describe the different signals from the sensors and physical principles involved in the sensors and transducers.	**K1**
CO2	explain the working principle of different sensors and transducers	**K2**
CO3	using the principle of sensors, and transducers to sense the physical quantity.	**K3**
CO4	categorize the sensors, transducers and recommend this to suitable applications.	**K4**
CO5	assess the performance of the circuits and interpret it's working.	**K5**
CO6	examine the signals, design the transducers for the applications and synthesize a new sensors and transducers.	**K6**

Relationship Matrix										
Semester	**Course Code**	**Title of the Course**						**Hours**		**Credits**
4	**23PPH4ES03B**	**Elective - 4:** Physics of Sensors and Transducers						**5**		**4**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**				**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	2	3	3	2	2	2	2	3	2	**2.3**
CO2	3	2	2	2	3	2	3	3	3	2	**2.5**
CO3	3	2	2	2	2	2	3	3	3	2	**2.4**
CO4	3	2	3	2	2	3	3	2	2	3	**2.5**
CO5	3	2	2	2	2	3	3	3	2	2	**2.4**
CO6	3	2	2	2	2	3	3	3	2	2	**2.4**
										Mean Overall Score	**2.42 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
4	23PPH4CE01	Comprehensive Examination	-	2

UNIT I: Classical and Quantum Mechanics

Generalized coordinates system, Lagrangian and Hamiltonian formulation and equation of motion, Central force motions, two body collisions - Scattering in laboratory and center of mass frames, Rigid body dynamics - nonlinear frame and pseudo forces, Special theory of relativity - Lorentz transformation, relativistic Kinematics and mass energy Equivalence. Basic postulates and quantum system - Schrodinger equation and wave packets - Properties of 1D motions, one- and three-dimensional problems - Tunneling through barrier - Eigen value problems - Harmonic oscillator and Hydrogen atom problem, Angular momentum - spin angular momentum - orbital angular momentum - Iso spin, Approximation methods - Time independent Perturbation Theory - JWKB approximation.

UNIT II: Mathematical Physics and Mathematical methods of Computational Physics

Mathematical tools of vector and matrix spaces - vector algebra and vector calculus, linear algebra, matrices, Eigen values and Eigen vectors, partial differential equations - Laplace, wave and heat equations in two and three dimensions- Cauchy's theorem - Laurent series, Fourier series - Fourier and Laplace transforms, Special function – series solution of Hermite and Legendre polynomial Rearrangement theorem - cyclic groups - subgroups - conjugate elements and class structure - identification of symmetry element and operations - molecular point groups - The Great Orthogonality theorem (Qualitative treatments) - Character table - generating symmetry operators - irreducible representation for C2v and C3v - Numerical integration - Interpolation.

UNIT III: Methods of spectroscopy and Condensed Matter Physics

Electronic, rotational, vibrational and Raman spectra of diatomic molecules - selection rule, Spin and applied field - NMR spectroscopy - Electron spin resonance spectroscopy - Mossbauer Spectroscopy Semiconductor crystals - Origin of energy gap - carrier concentration - mobility - conductivity - Fermi surface - construction of Fermi surface - nearly free electron model - Pseudo potential Thermodynamics of the superconducting transition - London equation - BCS theory of superconductivity - Type II superconductors - DC and AC Josephson effect - High temperature superconductors, Magnetic properties of solids - Dia, para and ferro magnetism, magnetic resonance, dielectric function of gas.

UNIT IV: Electromagnetic Theory

Gauss law and its applications - Laplace and Poisson equations - boundary value problems - Biot-Savart law - Ampere's theorem - Maxwell's equations in free space and linear isotropic media - Boundary conditions on fields at interface - Scalar and vector potential, Electromagnetic waves in free space, dielectrics and conductors, wave guides - Radiation from moving charges and retarded potential.

UNIT V: Nuclear Physics and Statistical Mechanics

Basic nuclear properties - nuclear models - Theories of alpha and beta decay, types of nuclear reactions, elementary particles and their quantum numbers - Quark model, Cosmic rays - discovery and applications, diagnostic nuclear medicine.

Fundamentals of statistical mechanics, classical statistical mechanics - micro and macro states, thermodynamic quantities, Maxwell's relations, Boltzmann's entropy relation, quantum statistical mechanics - ideal Bose and Fermi gas - Bose-Einstein condensation, Transport properties - Boltzmann transport equations - random walk - Brownian movement.

Books for Reference

1. Gupta, A., & Tomar, S. (2022). *Upkar's CSIR-UGC NET /JRF/SET Physical Sciences*. Upkar Prakashan publication.
2. (2020). *NTA CSIR UGC NET SET (JRF & Lectureship) Physical Sciences*. Arihant Publications.