ANNAMALAI UNIVERSITY

(Accredited with 'A^{+}' Grade by NAAC)

M.Sc. Physics

(Two Year Programme)

Regulations & Curriculum (2023 - 2024)

Department of Physics

DST – FIST Supported

ANNAMALAI UNIVERSITY

FACULTY OF SCIENCE
DEPARTMENT OF PHYSICS
M.Sc. PHYSICS
Programme Code: SPHY21
CHOICE BASED CREDIT SYSTEM (CBCS)
REGULATIONS AND SYLLABUS
(2023-2024 onwards)

These Regulations are common to all the students admitted to the Two-Year Master's Programmes in the Faculties of Arts, Science, Indian Languages, Education, Marine Sciences, and Fine Arts from the academic year 2023-2024 onwards.

1. Definitions and Nomenclature

1.1 **University** refers to Annamalai University.

1.2 **Department** means any of the academic departments and academic centres at the University.

1.3 **Discipline** refers to the specialization or branch of knowledge taught and researched in higher education. For example, Botany is a discipline in the Natural Sciences, while Economics is a discipline in Social Sciences.

1.4 **Programme**encompasses the combination of courses and/or requirements leading to a Degree. For example, M.A., M.Sc.

1.5 **Course** is an individual subject in a programme. Each course may consist of Lectures/Tutorials/Laboratory work/Seminar/Project work/Experiential learning/ Report writing/viva-voce etc. Each course has a course title and is identified by a course code.

1.6 **Curriculum** encompasses the totality of student experiences that occur during the educational process.

1.7 **Syllabus** is an academic document that contains the complete information about an academic programme and defines responsibilities and outcomes. This includes course information, course objectives, policies, evaluation, grading, learning resources and course calendar.

1.8 **Academic Year** refers to the annual period of sessions of the University that comprises two consecutive semesters.

1.9 **Semester** is a half-year term that lasts for a minimum duration of 90 days. Each academic year is divided into two semesters.

1.10 **Choice Based Credit System** A mode of learning in higher education that enables a student to have the freedom to select his/her own choice of elective courses across various disciplines for completing the Degree programme.

1.11 **Core Course** is mandatory and an essential requirement to qualify for the Degree.

1.12 **Elective Course** is a course that a student can choose from a range of alternatives.

1.13 **Skill Enhancement Courses and Value-added Courses** are optional courses that complement the students' knowledge and skills and enhance their employability.

1.14 **Credit** refers to the quantum of course work in terms of number of class hours in a semester required for a programme. The credit value reflects the content and duration of a particular course in the curriculum.

1.15 **Credit Hour** refers to the number of class hours per week required for a course in a semester. It is used to calculate the credit value of a particular course.

1.16 Programme Outcomes (POs) are statements that describe crucial and essential knowledge, skills and attitudes that students are expected to achieve and can reliably manifest at the end of a programme.

1.17 Programme Specific Outcomes (PSOs) are statements that list what the graduate of a specific programme should be able to do at the end of the programme.

1.18 Learning Objectives also known as Course Objectives are statements that define the expected goal of a course in terms of demonstrable skills or knowledge that will be acquired by a student as a result of instruction.

1.19 Course Outcomes (COs) are statements that describe what students should be able to achieve/demonstrate at the end of a course. They allow follow-up and measurement of learning objectives.

1.20 Grade Point Average (GPA) is the average of the grades acquired in various courses that a student has taken in a semester. The formula for computing GPA is given in section 11.3

1.21 Cumulative Grade Point Average (CGPA) is a measure of overall cumulative performance of a student over all the semesters. The CGPA is the ratio of total credit points secured by a student in various courses in all semesters and the sum of the total credits of all courses in all the semesters.

1.22 Letter Grade isan index of the performance of a student in a particular course. Grades are denoted by the letters S, A, B, C, D, E, RA, and W.

2. Programme Offered and Eligibility Criteria

Faculty of Science	
M.Sc. Physics	A pass in B.Sc. Physics as major subject and Mathematics and Chemistry as ancillary subjects from any University with not less than 50% of marks in Part–III.

2.1 In the case of SC/ST and Differently-abled candidates, a pass is the minimum qualification for the above Programme.

3. Reservation Policy

Admission to the programme will be strictly based on the reservation policy of the Government of Tamil Nadu.

4. Programme Duration

4.1 The Two Year Master's Programme consists of two academic years.

4.2 Each academic year is divided into two semesters, the first being from July to November and the second from December to April.

4.3 Each semester will have 90 working days (18 weeks).

5. Programme Structure

5.1 The Two Year Master's Programme consists of Core Courses, Elective Courses (Departmental & Interdepartmental), and Project.

5.2 Core courses

5.2.1. These are a set of compulsory courses essential for each programme.

5.2.2. The core courses include both Theory (Core Theory) and Practical (Core Practical) courses.

5.3. Elective courses

5.3.1 Departmental Electives (DEs) are the Electives that students can choose from a range of Electives offered within the Department.

5.4. Experiential Learning

5.4.1. Experiential learning provides opportunities to students to connect principles of the discipline with real-life situations.

5.4.2. In-plant training/field trips/internships/industrial visits (as applicable) fall under this category.

5.4.3. Experiential learning is categorized as Core.

5.5. Project

5.5.1. Each student shall undertake a Project in the final semester.

5.5.2. The Head of the Department shall assign a Research Supervisor to the student.

5.5.3. The Research Supervisor shall assign a topic for research and monitor the progress of the student periodically.

5.5.4. Students who wish to undertake project work in recognized institutions/industry shall obtain prior permission from the University. The Research Supervisor will be from the host institute, while the Co-Supervisor shall be a faculty in the parent department.

5.6. Skill Enhancement Courses (SECs)

5.6.1. Students may also opt to take skill enhancement courses. These courses impart employable and life skills. SECs are listed in the Handbook on departmental curriculum.

5.7. Internship

5.7.1. Internship willbecarriedoutduringthesummervacationofthefirstyearandmarkswillbeincludedintheThirdSemesterMarks Statement

5.7.2. Students shall put in a minimum attendance of 10 days duly certified by the Internship Co-ordinator

5.8. Extension Activities

5.8.1. It is mandatory for every student to participate in extension activities.

5.8.2. All the students shall enroll under NSS/NCC/YRC/RRC or any other Service Organisation in the University.

5.8.3. Students shall put in a minimum attendance of 40 hours in a year duly certified by the Programme Co-ordinator.

5.8.4. Extension activities shall be conducted outside the class hours.

5.9. Online Courses

5.9.1. The Heads of Departments shall facilitate enrolment of students in Massive Open OnlineCourses (MOOCs) platform such as SWAYAM to provide academic flexibility and enhance the academic career of students.

5.9.2. Students who successfully complete a course in the MOOCs platform shall be exempted from one elective course of the programme.

5.10. Credit Distribution

The credit distribution is organized as follows:

	Credits
Core Courses	57
Elective Courses	18
Project	07
Skill Enhancement Courses	06
Internship / Industrial Activity	02
Extension Activity	01
Total (Minimum requirement for award of Degree)	**91**

5.11. Credit Assignment

Each course is assigned credits and credit hours on the following basis:

1 Credit is defined as:

1 Lecture period of one hour per week over a semester

1 Tutorial period of one hour per week over a semester

1 Practical/Project period of two or three hours (depending on the discipline)

per week over a semester.

6. Attendance

6.1 Each faculty handling a course shall be responsible for the maintenance of Attendance and Assessment Record for candidates who have registered for the course.

6.2 The Record shall contain details of the students' attendance, marks obtained in the Continuous Internal Assessment (CIA) Tests, Assignments and Seminars. In addition the Record shall also contain the organisation of lesson plan of the Course Instructor.

6.3 The record shall be submitted to the Head of the Department once a month for monitoring the attendance and syllabus coverage.

6.4 At the end of the semester, the record shall be duly signed by the Course Instructor and the Head of the Department and placed in safe custody for any future verification.

6.5 The Course Instructor shall intimate to the Head of the Department at least seven calendar days before the last instruction day in the semester about the attendance particulars of all students.

6.6 Each student shall have a minimum of 75% attendance in all the courses of the particular semester failing which he or she will not be permitted to write the End-Semester Examination. The student has to redo the semester in the next year.

6.7 Relaxation of attendance requirement up to 10% may be granted for valid reasons such as illness, representing the University in extracurricular activities and participation in NCC/NSS/YRC/RRC.

7. Mentor-Mentee System

7.1. To help the students in planning their course of study and for general advice on the academic programme, the Head of the Department will attach certain number of students to a member of the faculty who shall function as a Mentor throughout their period of study.

7.2. The Mentors will guide their mentees with the curriculum, monitor their progress, and provide intellectual and emotional support.

7.3. The Mentors shall also help their mentees to choose appropriate electives and value-added courses, apply for scholarships, undertake projects, prepare for competitive examinations such as NET/SET, GATE etc., attend campus interviews and participate in extracurricular activities.

8. Examinations

8.1. The examination system of the University is designed to systematically test the student's progress in class, laboratory and field work through Continuous Internal Assessment (CIA) Tests and End-Semester Examination (ESE).

8.2. There will be two CIA Tests and one ESE in each semester.

8.3. The Question Papers will be framed to test different levels of learning based on Bloom's taxonomy viz. Knowledge, Comprehension, Application, Analysis, Synthesis and Evaluation/Creativity.

8.4. Continuous Internal Assessment Tests

8.4.1. The CIA Tests shall be a combination of a variety of tools such as class tests, assignments, seminars, and viva-voce that would be suitable to the course. This requires an element of openness.

8.4.2. The students are to be informed in advance about the assessment procedures.

8.4.3. The pattern of question paper will be decided by the respective faculty.

8.4.4. CIA Test-I will cover the syllabus of the first two units while CIA Test-II will cover the last three units.

8.4.5. CIA Tests will be for two to three hours duration depending on the quantum of syllabus.

8.4.6. A student cannot repeat the CIA Test-I and CIA Test-II. However, if for any valid reason, the student is unable to attend the test, the prerogative of arranging a special test lies with the teacher in consultation with the Head of the Department.

8.5. End Semester Examinations (ESE)

8.5.1. The ESE for the first/third semester will be conducted in November and for the second/fourth semester in May.

8.5.2. A candidate who does not pass the examination in any course(s) of the first, second and third semesters will be permitted to reappear in such course(s) that will be held in April and November in the subsequent semester/year.

8.5.3. The ESE will be of three hours duration and will cover the entire syllabus of the course.

9. Evaluation

9.1. Marks Distribution

9.1.1. Each course, Theory and Practical as well as Project/Internship/Field work/In-plant training shall be evaluated for a maximum of 100 marks.

9.1.2. For the theory courses, CIA Tests will carry 25% and the ESE 75% of the marks.

9.1.3. For the Practical courses, the CIA Tests will constitute 25% and the ESE 75% of the marks.

9.2. Assessment of CIA Tests

9.2.1. For the CIA Tests, the assessment will be done by the Course Instructor

9.2.2. For the Theory Courses, the break-up of marks shall be as follows:

	Marks
Test-I	10
Test-II	10
Seminar & Assignment	05
Total	25

9.2.3. For the Practical Courses (wherever applicable), the break-up of marks shall be as follows:

	Marks
Test-I	10
Test-II	10
Viva-voce and Record	05
Total	25

9.3. Assessment of End-Semester Examinations

9.3.1. Evaluation for the ESE is done by both External and Internal examiners (Double Evaluation).

9.3.2. In case of a discrepancy of more than 10% between the two examiners in awarding marks, third evaluation will be resorted to.

9.4. Assessment of Project/Dissertation

9.4.1. The Project Report/Dissertation shall be submitted as per the guidelines laid down by the University.

9.4.2. The Project Work/Dissertation shall carry a maximum of 100 marks.

9.4.3. CIA for Project will consist of a Review of literature survey, experimentation/field work, attendance etc.

9.4.4. The Project Report evaluation and viva-voce will be conducted by a committee constituted by the Head of the Department.

9.4.5. The Project Evaluation Committee will comprise the Head of the Department, Project Supervisor, and a senior faculty.

9.4.6. The marks shall be distributed as follows:

Continuous Internal Assessment (25 Marks)		End Semester Examination (75 Marks)	
Review-I 10 marks	Review-II: 15 marks	Project / Dissertation Evaluation	Viva-voce
		50 marks	25 marks

9.5. Assessment of Value-added Courses

9.5.1. Students may also opt to take value added courses beyond the minimum credits required for award of the degree VACs are outside the normal credit paradigm.

9.5.2. These courses impart employable and life skills. VACs are listed in the university website and in the Handbook on Interdepartmental Elective and VACs**.**

9.5.3. Assessment of VACs shall be internal.

9.5.4. Two CIA Tests shall be conducted during the semester by the Department(s) offering VAC.

9.5.5. A committee consisting of the Head of the Department, faculty handling the course and a senior faculty member shall monitor the evaluation process.

9.5.6. The grades obtained in VACs will not be included for calculating the GPA.

9.6. Passing Minimum

9.6.1. A student is declared to have passed in each course if he/she secures not less than 50% marks in the ESE and not less than 50% marks in aggregate taking CIA and ESE marks together.

9.6.2. A candidate who has not secured a minimum of 50% of marks in a course (CIA + ESE) shall reappear for the course in the next semester/year.

10. Conferment of the Master's Degree

A candidate who has secured a minimum of 50% marks in all courses prescribed in the programme and earned the minimum required credits shall be considered to have passed the Master's Programme.

11. Marks and Grading

11.1. The performance of students in each course is evaluated in terms Grade Point (GP).

11.2. The sum total performance in each semester is rated by Grade Point Average (GPA) while Cumulative Grade Point Average (CGPA) indicates the Average Grade Point obtained for all the courses completed from the first semester to the current semester.

11.3. The GPA is calculated by the formula

$$\mathrm{GPA} = \frac{\sum_{i=1}^{n} C_i G_i}{\sum_{i=1}^{n} C_i}$$

where, $\mathbf{C_i}$ is the Credit earned for the Course **i** in any semester;

$\mathbf{G_i}$ is the Grade Point obtained by the student for the Course **i** and

n is the number of Courses passed in that semester.

11.4. **CGPA** is the Weighted Average Grade Point of all the Courses passed starting from the first semester to the current semester.

$$\mathrm{CGPA} = \frac{\sum_{i=1}^{m} \sum_{i=1}^{n} C_i G_i}{\sum_{i=1}^{m} \sum_{i=1}^{n} C_i}$$

where, $\mathbf{C_i}$ is the Credit earned for the Course **i** in any semester;

$\mathbf{G_i}$ is the Grade Point obtained by the student for the Course **i** and

n is the number of Courses passedin that semester.

mis the number of semesters

11.5. Evaluation of the performance of the student will be rated as shown in the Table.

Letter Grade	Grade Points	Marks %
S	10	90 and above
A	9	80-89
B	8	70-79
C	7	60-69
D	6	55-59
E	5	50-54
RA	0	Less than 50
W	0	Withdrawn from the examination

11.6. Classification of Results. The successful candidates are classified as follows:

11.6.1. For **First Class with Distinction:** Candidates who have passed all the courses prescribed in the Programme in the first attempt with a CGPA of 8.25 or above within the programme duration. Candidates who have withdrawn from the End Semester Examinations are still eligible for First Class with Distinction (See Section 12 for details).

11.6.2. For **First Class:** Candidates who have passed all the courses with a CGPA of 6.5 or above.

11.6.3. For **Second Class:** Candidates who have passed all the courses with a CGPA between 5.0 and less than 6.5.

11.6.4. Candidates who obtain highest marks in all examinations at the first appearance alone will be considered for University Rank.

11.7. Course-Wise Letter Grades

11.7.1. The percentage of marks obtained by a candidate in a course will be indicated in a letter grade.

11.7.2. A student is considered to have completed a course successfully and earned the credits if he/she secures an overall letter grade other than RA.

11.7.3. A course successfully completed cannot be repeated for the purpose of improving the Grade Point.

11.7.4. A letter grade RA indicates that the candidate shall reappear for that course. The RA Grade once awarded stays in the grade card of the student and is not deleted even when he/she completes the course successfully later. The grade acquired later by the student will be indicated in the grade sheet of the Odd/Even semester in which the candidate has appeared for clearance of the arrears.

11.7.5. If a student secures RA grade in the Project Work/Field Work/Practical Work/Dissertation, he/she shall improve it and resubmit if it involves only rewriting/ incorporating the clarifications suggested by the evaluators or he/she can re-register and carry out the same in the subsequent semesters for evaluation.

12. Provision for Withdrawal from the End Semester Examination

12.1. The letter grade W indicates that a candidate has withdrawn from the examination.

12.2. A candidate is permitted to withdraw from appearing in the ESE for one course or courses in ANY ONE of the semesters ONLY for exigencies deemed valid by the University authorities.

12.3. Permission for withdrawal from the examination shall be granted only onceduring the entire duration of the programme.

12.4. Application for withdrawal shall be considered only if the student has registered for the course(s), and fulfilled the requirements for attendance and CIA tests.

12.5. The application for withdrawal shall be made ten days prior to the commencement of the examination and duly approved by the Controller of Examinations. Notwithstanding the mandatory prerequisite of ten days' notice, due consideration will be given under extraordinary circumstances.

12.6. Withdrawal is not granted for arrear examinations of courses in previous semesters and for the final semester examinations.

12.7. Candidates who have been granted permission to withdraw from the examination shall reappear for the course(s) when the course(s) are offered next.

12.8. Withdrawal shall not be taken into account as an appearance for the examination when considering the eligibility of the candidate to qualify for First Class with Distinction.

13. Academic misconduct

Any action that results in an unfair academic advantage/interference with the functioning of the academic community constitutes academic misconduct. This includes but is not limited to cheating, plagiarism, altering academic documents, fabrication/falsification of data, submitting the work of another student, interfering with other students' work, removing/defacing library or computer resources, stealing other students' notes/assignments, and electronically interfering with other students'/University's intellectual property. Since many of these acts may be committed unintentionally due to lack of awareness, students shall be sensitized on issues of academic integrity and ethics.

14. Transitory Regulations

Wherever there has been a change of syllabi, examinations based on the existing syllabus will be conducted for two consecutive years after implementation of the new syllabus in order to enable the students to clear the arrears. Beyond that, the students will have to take up their examinations in equivalent subjects, as per the new syllabus, on the recommendation of the Head of the Department concerned.

15. Notwithstanding anything contained in the above pages as Rules and Regulations governing the Two Year Master's Programmes at Annamalai University, the Syndicate is vested with the powers to revise them from time to time on the recommendations of the Academic Council.

M.Sc Physics (Two Year)
Programme Code: SPHY21

Programme Structure and Scheme of Examination
(For the candidates admitted from the academic year 2023 -2024 onwards)

Course Code	Course Title	Credit	Hours/Week	Maximum Marks		
				CIA	ESE	Total
	SEMESTER – I					
23PHYC101	Core 1: Classical Mechanics and Relativity	5	7	25	75	100
23PHYC102	Core 2: Linear and Digital ICs and Applications	5	7	25	75	100
23PHYP103	Core 3: Practical – I	4	6	25	75	100
23PHYE104	Elective – I	3	5	25	75	100
23PHYE105	Elective– II	3	5	25	75	100
	Total	**20**	**30**			**500**
	SEMESTER – II					
23PHYC201	Core 4: Mathematical Physics	5	6	25	75	100
23PHYC202	Core 5: Quantum Mechanics – I	5	6	25	75	100
23PHYP203	Core 6: Practical – II	4	6	25	75	100
23PHYE204	Elective – III	3	4	25	75	100
23PHYE205	Elective– IV	3	4	25	75	100
23PHYS206	Skill Enhancement Courses - I	2	4	25	75	100
	Total	**22**	**30**			**600**
	SEMESTER – III					
23PHYC301	Core 7: Quantum Mechanics – II	5	6	25	75	100
23PHYC302	Core 8: Condensed Matter Physics	5	6	25	75	100
23PHYC303	Core 9: Electromagnetic Theory	5	6	25	75	100
23PHYP304	Core 10: Practical – III	4	6	25	75	100
23PHYE305	Elective – V	3	3	25	75	100
23PHYS306	Skill Enhancement Courses - II	2	3	25	75	100
23PHYI307	*Internship / Industrial Activity	2	-	25	75	100
	Total	**26**	**30**			**700**
	SEMESTER – IV					
23PHYC401	Core 11: Nuclear and Particle Physics	5	6	25	75	100
23PHYC402	Core 12: Spectroscopy	5	6	25	75	100
23PHYD403	Project with Viva-voce	7	10	25	75	100
23PHYE404	Elective VI - (Industry /Entrepreneurship) 80% P 20% T	3	4	25	75	100
23PHYS405	Skill Enhancement Courses – III	2	4	25	75	100
23PHYX406	Extension Activity	1	-	-	-	100
	Total	**23**	**30**			**600**
	Total Credits / Hours	**91**	**120**			**2400**

C- Credits; CIA- Continuous Internal Assessment; ESE- End-Semester Examination

Note:

1. **Students shall take Department Electives and Skill Enhancement Courses (SECs) from a range of choices available.**

***Internshipwillbecarriedoutduringthesummervacationofthefirstyearandmarkswillbe includedintheThirdSemesterMarks Statement.**

Department Elective Courses

Semester	Course Code	Course Title
I (Elective-I)	23PHYE104	Material Science
		Digital Communication
		Communication Electronics
I (Elective-II)	23PHYE105	Energy Physics
		Bio Physics
		Crystal Growth and Thin films
II (Elective-III)	23PHYE204	Advanced Optics
		Advanced Mathematical Physics
		Plasma Physics
II (Elective-IV)	23PHYE205	Microprocessor 8085 and Microcontroller 8051
		Advanced Spectroscopy
		Medical Physics
III (Elective-V)	23PHYE305	Physics of Nanoscience and Technology
		Solid Waste Management
		SewageandWasteWaterTreatmentand Reuse
IV (Elective-VI)	23PHYE404	Characterization of Materials

Skill Enhancement Courses (SEC)

Semester	Course Code	Course Title
II (SEC-I)	23TSSC200	Academic writing skills
	23PHYS206	Solar Energy Utilization
III (SEC-II)	23PHYS306	Physics for Medical Instrumentation
		Computational Physics
IV (SEC-III)	23PHYS405	Numerical Methods and Computer Programming
		Research Tools and Techniques

Consolidation (Credits Distribution)**:**

S.No.	Subject	Credits Distribution	Total
1	Core	9 x 5	45
2	Core Practical	3 x 4	12
3	Project	1 x 7	07
4	Elective	6 x 3	18
5	SEC	3 x 2	06
6	Internship	1 x 2	02
7	Extension Activity	1 x 1	01
	TOTAL		**91**

Preamble

The curriculum for the P.G. Physics for universities and colleges is revised as per Learning Outcomes- based Curriculum Framework (LOCF). The learner centric courses are designed to enable the students to progressively develop a good understanding of the concepts of various domains in physics. Significant modification is the inclusion of the courses to equip students to face challenges in industries and make them employable. Skill development in different spheres and confidence building are given a special focus.

TANSCHE REGULATIONS ON LEARNING OUTCOMES-BASED CURRICULUM FRAMEWORK FOR POSTGRADUATE EDUCATION	
Programme	**M. Sc., Physics**
Programme Code	**SPHY21**
Duration	**PG – 2 YEARS**
Programme Outcomes (POs)	**PO1: Problem Solving Skill** Apply knowledge of Management theories and Human Resource practices to solve business problems through research in Global context. **PO2: Decision Making Skill** Foster analytical and critical thinking abilities for data-based decision-making. **PO3: Ethical Value** Ability to incorporate quality, ethical and legal value-based perspectives to all organizational activities. **PO4: Communication Skill** Ability to develop communication, managerial and interpersonal skills. **PO5: Individual and Team Leadership Skill** Capability to lead themselves and the team to achieve organizational goals. **PO6: Employability Skill** Inculcate contemporary business practices to enhance employability skills in the competitive environment. **PO7: Entrepreneurial Skill** Equip with skills and competencies to become an entrepreneur. **PO8: Contribution to Society** Succeed in career endeavors and contribute significantly to society. **PO 9 Multicultural competence** Possess knowledge of the values and beliefs of multiple cultures and a global perspective. **PO 10: Moral and ethical awareness/reasoning** Ability to embrace moral/ethical values in conducting one's life.

Programme Specific Outcomes (PSOs)	**PSO1 – Placement** To prepare the students who will demonstrate respectful engagement with others' ideas, behaviors, beliefs and apply diverse frames of reference to decisions and actions. **PSO 2 - Entrepreneur** To create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate startups and high potential organizations. **PSO3 – Research and Development** Design and implement HR systems and practices grounded in research that comply with employment laws, leading the organization towards growth and development. **PSO4 – Contribution to Business World** To produce employable, ethical and innovative professionals to sustain in the dynamic business world. **PSO 5 – Contribution to the Society** To contribute to the development of the society by collaborating with stakeholders for mutual benefit. **PSO 6** Students will utilize e-resources, digital tools and techniques for widening their knowledge base. **PSO 7** Students gain exposure to programming language and skills. **PSO 8** Student will appreciate the interplay of mathematics, physics and technology. **PSO 9** Students will develop adequate knowledge and skills for employment and entrepreneurship. **PSO 10** An awareness of civic and ecological duties as good citizens and importance of human values will be inculcated in students

MAPPING OF PROGRAMME SPECIFIC OUTCOMES WITH PROGRAMME OUTCOMES

By the end of the program, the students will be able to

Programme Specific Outcomes (PSOs)	**Programme Outcomes (POs)**									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
PSO1	3	3	3	3	3	3	3	3	3	3
PSO2	3	3	2	3	2	2	2	2	1	1
PSO3	3	3	1	2	2	2	2	2	1	1
PSO4	3	3	3	3	3	3	3	3	3	3
P5O5	3	3	1	3	2	2	3	3	3	3
PSO6	3	3	3	3	3	3	3	3	3	3
PSO7	3	3	3	3	3	3	3	3	3	3
PSO8	3	3	2	3	3	3	2	3	2	2
PSO9	3	3	3	3	2	3	3	2	3	2
PSO10	3	3	3	3	3	2	3	3	2	2

SYLLABUS

Paper-1-CLASSICALMECHANICSANDRELATIVITY	**IYEAR- FIRSTSEMESTER**

Subject Code	**SubjectName**	**Category**	**L**	**T**	**P**	**Credits**	**Inst.Hours**	**Marks**
23PHYC101	**CLASSICAL MECHANICS ANDRELATIVITY**	Core	6	1		5	7	75

Pre-Requisites
Fundamentalsofmechanics,Foundationinmathematicalmethods.
LearningObjectives
➢ Tounderstandfundamentalsofclassicalmechanics. ➢ TounderstandLagrangianformulationofmechanicsandapplyittosolveequationofmotion. ➢ TounderstandHamiltonianformulationofmechanics andapplyittosolveequationofmotion. ➢ To discuss thetheoryof small oscillationsofasystem. ➢ Tolearntherelativisticformulationofmechanicsofasystem.

UNITS	**CourseDetails**
UNITI: PRINCIPLESOF CLASSICAL MECHANICS	Mechanics of a single particle – mechanics of a system of particles – conservationlawsforasystemofparticles–constraints–holonomic&non-holonomicconstraints–generalizedcoordinates–configurationspace–transformationequations–principleofvirtual work.
UNIT II: LAGRANGIANFORMULATION	D‘Alembert‘sprinciple – Lagrangianequations of motion for conservative systems – applications:(i)simplependulum(ii)Atwood‘smachine (iii) projectilemotion.
UNIT III:HAMILTONIANFORMULATION	Phasespace–cycliccoordinates–conjugatemomentum–Hamiltonian function – Hamilton‘s canonical equations of motion – applications:(i)simplependulum(ii)onedimensionalsimple harmonicoscillator(iii)motion ofparticleinacentralforcefield.
UNITIV: SMALLOSCILLATIONS	Formulationoftheproblem–transformationtonormalcoordinates–frequenciesof normalmodes– linear triatomicmolecule.
UNITV: RELATIVITY	Inertialandnon-inertialframes–Lorentztransformationequations–lengthcontractionandtimedilation–relativisticadditionofvelocities – Einstein‘smass-energyrelation–Minkowski‘sspace–fourvectors – position,velocity,momentum,accelerationandforceinvectornotational and theirtransformations

UNIT VI:PROFESSIONALCOMPONENTS	ExpertLectures,OnlineSeminars-WebinarsonIndustrialInteractions/Visits,CompetitiveExaminations,EmployableandCommunicationSkillEnhancement,Social Accountabilityand Patriotism

TEXTBOOKS	1. H.Goldstein,2002,*ClassicalMechanics*,3rdEdition,PearsonEdu. 2. J.C.Upadhyaya,*ClassicalMechanics*,HimalayaPublshing.Co.NewDelhi. 3. R.Resnick,1968,*IntroductiontoSpecialTheoryofRelativity*, WileyEastern,NewDelhi. 4. R.G.TakwalaandP.S.Puranik,IntroductiontoClassicalMechanics–Tata–McGrawHill,NewDelhi, 1980. 5. N.C.RanaandP.S.Joag,ClassicalMechanics-TataMcGrawHill, 2001
REFERENCE BOOKS	1. K.R.Symon,1971,*Mechanics*,AddisonWesley,London. 2. S.N.Biswas,1999,*ClassicalMechanics*,Books&Allied,Kolkata. 3. GuptaandKumar,*ClassicalMechanics*,KedarNath. 4. T.W.B.Kibble,*ClassicalMechanics*,ELBS. 5. Greenwood,*ClassicalDynamics*,PHI,NewDelhi.
WEBSOURCES	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-pdf-free.html 3. https://nptel.ac.in/courses/122/106/122106027/ 4. https://ocw.mit.edu/courses/physics/8-09-classical-mechanics- iii-fall-2014/lecture-notes/ 5. https://www.britannica.com/science/relativistic-mechanics

COURSEOUTCOMES:

Attheend ofthecoursethestudent willbeableto:

CO1	Understandthe fundamentalsofclassicalmechanics.	**K2**
CO2	ApplytheprinciplesofLagrangianandHamiltonianmechanicstosolve theequationsofmotionofphysicalsystems.	**K3**
CO3	ApplytheprinciplesofLagrangianandHamiltonianmechanicstosolve theequationsofmotionofphysicalsystems.	**K3, K5**
CO4	Analyzethesmalloscillationsinsystemsanddeterminetheirnormal modesofoscillations.	**K4, K5**
CO5	Understandandapplytheprinciplesofrelativistickinematicstothe mechanicalsystems.	**K2, K3**
K1-Remember; K2–Understand;K3-Apply;K4-Analyze;K5–Evaluate		

MAPPINGWITHPROGRAMOUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specificoutcomes**(PSO)** inthe 3-pointscaleofSTRONG(3),MEDIUM(2)andLOW(1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	2	3	3	3	2	2	2	3	2	2
CO2	2	3	3	3	2	2	2	3	2	2
CO3	2	3	3	3	2	2	2	3	2	2
CO4	2	3	3	3	2	2	2	3	2	2
CO5	2	3	3	3	2	2	2	3	2	2

Strong– 3,Medium – 2,Low-1

Paper-2-LINEARANDDIGITALICs&APPLICATIONS	**IYEAR- FIRSTSEMESTER**

Subject Code	**SubjectName**	**Category**	**L**	**T**	**P**	**Credits**	**Inst.Hours**	**Marks**
23PHYC102	**LINEARANDDIGITALICsANDAPPLICATIONS**	Core	6	1		5	7	75

Pre-Requisites
Knowledgeofsemiconductordevices,basicconceptsofdigitalandanalogelectronics
LearningObjectives
➢ Tointroducethe basicbuildingblocksoflinearintegratedcircuits. ➢ Toteachthelinearandnon-linearapplicationsofoperational amplifiers. ➢ Tointroducethe theoryand applicationsofPLL. ➢ TointroducetheconceptsofwaveformgenerationandintroduceonespecialfunctionICs. ➢ ExposuretodigitalIC_s

UNITS	**CourseDetails**
UNIT I:INTEGRATEDCIRCUITSANDOPERATIONALAMPLIFIER	Introduction, Classification of IC's, basic information of Op-Amp 741 andits features, the ideal Operational amplifier, Op-Amp internal circuit andOp-AmpCharacteristics.

UNIT II:APPLICATIONS OFOP-AMP	LINEARAPPLICATIONSOFOP-AMP:Solutiontosimultaneousequationsanddifferentialequations,Instrumentationamplifiers,VtoIandIto Vconverters. NON-LINEARAPPLICATIONSOFOP-AMP:Sample and Hold circuit, Log and Antilog amplifier, multiplier and divider,Comparators,Schmitttrigger,Multivibrators,TriangularandSquarewaveformgenerators.
UNIT III: **ACTIVEFILTERS& TIMERANDPHASE LOCKEDLOOPS**	ACTIVE FILTERS: Introduction, Butterworth filters – 1st order, 2nd orderlowpassand highpassfilters, bandpass,band rejectand allpassfilters. TIMER AND PHASE LOCKED LOOPS: Introduction toIC555 timer,description of functional diagram, monostable and astable operations andapplications, Schmitttrigger, PLL - introduction,basic principle,phasedetector/comparator,voltagecontrolledoscillator(IC566),low passfilter, monolithicPLLandapplicationsofPLL
UNIT IV:VOLTAGER EGULATOR&D toA, AtoDCONVERT ERS	VOLTAGEREGULATOR:Introduction,SeriesOp-Ampregulator,ICVoltage Regulators, IC 723 general purpose regulators, SwitchingRegulator. DtoAANDAtoDCONVERTERS:Introduction,basicDACtechniques - weightedresistorDAC,R-2Rladder DAC,invertedR-2RDAC,AtoD converters-parallelcomparatortypeADC,counter typeADC,successive approximation ADC and dual slope ADC, DAC and ADCSpecifications.
UNITV: **CMOSLOGIC,CO MBINATIONALCI RCUITS USINGTTL74XXIC s** **&** **SEQUENTIALCI RCUITS USINGTTL74XXI Cs**	CMOS LOGIC: CMOS logic levels, MOS transistors, Basic CMOS Inverter,NANDandNORgates,CMOSAND-OR-INVERTandOR-AND-INVERTgates, implementation of any function using CMOS logic. COMBINATIONALCIRCUITSUSINGTTL74XXICs:Study oflogic gates using 74XX ICs,Four-bitparalleladder(IC7483),Comparator (IC7485),Decoder(IC74138,IC 74154),BCD to7-segmentdecoder (IC7447),Encoder(IC74147),Multiplexer(IC74151),Demultiplexer (IC 74154). SEQUENTIALCIRCUITSUSINGTTL74XXICs:FlipFlops(IC7474,IC7473),ShiftRegisters,UniversalShiftRegister(IC74194), 4-bitasynchronousbinarycounter(IC7493).
UNIT VI:PROFESSION ALCOMPONENT S	Expert Lectures, Online Seminars - Webinars on IndustrialInteractions/Visits, CompetitiveExaminations, Employable and CommunicationSkillEnhancement,SocialAccountabilityandPatriotism
TEXTBOOKS	1. D.RoyChoudhury,ShailB.Jain(2012),LinearIntegratedCircuit,4thedition,NewAge InternationalPvt.Ltd.,NewDelhi, India 2. RamakantA.Gayakwad,(2012),OP-AMPandLinearIntegratedCircuits,4thedition,PrenticeHall /PearsonEducation,NewDelhi. 3. B.L. Theraja and A.K. Theraja, 2004, A Textbook of Electricaltechnology, S.Chand&Co. 4. V.K.MehtaandRohitMehta,2008,PrinciplesofElectronics,SChand&Co,12thEdition. 5. V.Vijayendran,2008,IntroductiontoIntegratedelectronics(Digital&Analog),S.Viswanathan Printers &PublishersPrivateLtd,Reprint.V.

REFERENCEBOOKS	1. SergioFranco(1997),Designwithoperationalamplifiersandanalogintegratedcircuits,Mc GrawHill, NewDelhi. 2. Gray,Meyer(1995), AnalysisandDesignofAnalog IntegratedCircuits,WileyInternational,NewDelhi. 3. MalvinoandLeach(2005),DigitalPrinciplesandApplications5thEdition,TataMcGrawHil l,NewDelhi 4. Floyd,Jain(2009),DigitalFundamentals,8thedition,PearsonEducation,NewDelhi. 5. IntegratedElectronics,Millman&Halkias,TataMcGrawHill,17th Reprint(2000)
WEBSOURCES	1. https://nptel.ac.in/course.html/digitalcircuits/ 2. https://nptel.ac.in/course.html/electronics/operationalamplifier/ 3. https://www.allaboutcircuits.com/textbook/semiconductors/chpt-7/field-effect-controlled-thyristors/ 4. https://www.electrical4u.com/applications-of-op-amp/ 5. https://www.geeksforgeeks.org/digital-electronics-logic-design-tutorials/

COURSEOUTCOMES:

Attheend ofthecoursethestudent willbeableto:

CO1	Learnaboutthebasicconceptsforthecircuitconfigurationforthedesignoflinearinte gratedcircuits anddevelopsskilltosolveproblems	**K1,K5**
CO2	Developskillstodesignlinearandnon-linearapplicationscircuitsusingOp-Ampand designthe activefilterscircuits.	**K3**
CO3	Gainknowledgeabout PLL,anddeveloptheskillstodesignthesimplecircuits usingIC555timerandcansolveproblemsrelatedtoit.	**K1,K3**
CO4	LearnaboutvarioustechniquestodevelopA/DandD/Aconverters.	**K2**
CO5	AcquiretheknowledgeabouttheCMOSlogic,combinationalandsequentialcircuits	**K1,K4**
K1-Remember; K2–Understand;K3-Apply;K4-Analyze;K5–Evaluate		

MAPPINGWITHPROGRAMOUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specificoutcomes**(PSO)** inthe 3-pointscaleof STRONG(3), MEDIUM(2)andLOW(1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	3	3	2	2	3	3	3	2
CO2	3	3	3	3	1	3	3	3	2	1
CO3	3	3	3	3	1	3	3	3	2	1
CO4	3	3	3	3	1	3	3	3	2	1
CO5	3	3	3	2	1	1	2	3	2	1

Strong(3)Medium(2)andLow (1)

Paper-3- PRACTICAL I	IYEAR- FIRSTSEMESTER

Subject Code	SubjectName	Category	L	T	P	Credits	Inst.Hours	Marks
23PHYP103	**PRACTICALI**	Core			6	4	6	75

Pre-Requisites
Knowledgeandhandsonexperienceofbasicgeneral andelectronicsexperimentsofPhysics
LearningObjectives
➢ Tounderstandtheconceptofmechanicalbehaviorofmaterialsandcalculationofsameusingappropriateequations. ➢ Tocalculatethethermodynamicquantitiesandphysicalpropertiesof materials. ➢ Toanalyzetheopticalandelectricalpropertiesofmaterials.

CourseDetails

(AnyTwelveExperiments)

1. Determination of Young‘s modulus and Poisson‘s ratio by Hyperbolic fringes - Cornu‘sMethod.
2. DeterminationofRydberg‘sConstant -HydrogenSpectrum.
3. MeasurementofBandgapenergy-Thermistor.
4. DeterminationofCompressibilityofaliquidusingUltrasonics.
5. DeterminationofWavelength,Separationofwavelengths-MichelsonInterferometer.
6. GMcounter–Characteristics,inversesquarelawandabsorptioncoefficient.
7. MeasurementofConductivity-Four probemethod.
8. Measurementofwavelength ofDiode Laser/He– Ne LaserusingDiffraction grating.
9. ConstructionofrelaxationoscillatorusingUJT.
10. Mathematical operation usingIC741.
11. V-ICharacteristicsofdifferentcoloursofLED.
12. Study of attenuationcharacteristics of Wien‘s bridge network anddesignof Wien‘sbridgeoscillatorusingOp-Amp.
13. StudyofattenuationcharacteristicsofPhaseshiftnetworkanddesignofPhaseshiftoscillatorusingOp-Amp.
14. ConstructionofSchmidttriggercircuitusingIC741foragivenhysteresis-applicationassquarer.
15. ConstructionofsquarewaveTriangularwave generatorusingIC741.
16. ConstructionofOp-Amp-4bitDigitaltoAnalogconverter(BinaryWeightedandR/2Rladdertype).
17. StudyofR-S,clockedR-SandD-Flipflop usingNANDgates.
18. StudyofJ-K, Dand T flip flops usingIC7476/7473.
19. Arithmeticoperationsusing IC7483-4-bitbinaryadditionandsubtraction.
20. Studyof Arithmetic logicunitusing IC74181.

TEXTBOOKS	1. PracticalPhysics,GuptaandKumar,PragatiPrakasan. 2. KitDevelopedfordoingexperimentsinPhysics-Instructionmanual,R.SrinivasanK.RPriolkar, IndianAcademyofSciences. 3. ElectronicLaboratoryPrimeradesignapproach,S.PoornaChandra, B.Sasikala,WheelerPublishing,NewDelhi. 4. ElectroniclabmanualVolI,KANavas,RajathPublishing. 5. ElectroniclabmanualVolII,KANavas,PHIeasternEconomyEdition
REFERENCEBOOKS	1. AdvancedPracticalPhysics,S.PSingh,PragatiPrakasan. 2. Anadvancedcourse inPracticalPhysics,D.Chattopadhayay,C.RRakshit,NewCentralBookAgencyPvt.Ltd 3. Op-Ampandlinearintegratedcircuit,RamakanthAGaykwad,EasternEconomyEdition. 4. A course on experimentwith He-NeLaser,R.S. Sirohi, John Wiley &Sons (Asia)Pvt.Ltd. 5. ElectroniclabmanualVolII,KuriachanT.D,SyamMohan,AyodhyaPublishing.

COURSEOUTCOMES:

Attheend ofthecoursethestudent willbeableto:

CO1	UnderstandthestrengthofmaterialusingYoung‘smodulus.	**K2**
CO2	Acquireknowledgeof thermal behaviourof thematetials.	**K1**
CO3	Understandtheoreticalprinciplesofmagnetismthroughtheexperiments.	**K2**
CO4	Acquireknowledgeabout arcspectrumandapplicationsoflaser	**K1,K3**
CO5	ImprovetheanalyticalandobservationabilityinPhysicsExperiments	**K3, K5**
CO6	Conductexperiments onapplicationsofFETandUJT	**K4**
CO7	Analyzevariousparametersrelatedtooperationalamplifiers.	**K4**
CO8	Understandthe conceptsinvolvedinarithmeticandlogicalcircuitsusingIC‘s	**K2**
CO9	AcquireknowledgeaboutCombinationalLogicCircuitsandSequentialLogicCircuits	**K1**
CO10	Analyzetheapplicationsofcountersandregisters	**K4**
K1-Remember; K2–Understand;K3 -Apply;K4-Analyze;K5–Evaluate		

MAPPINGWITHPROGRAMOUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specificoutcomes**(PSO)** inthe 3-pointscaleofSTRONG(3),MEDIUM(2)andLOW(1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	2	2	2	3	2	2	2	1	2	3
CO2	2	2	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	2	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	2	2	2	2
CO6	2	2	2	3	3	1	1	1	3	3
CO7	2	2	3	3	3	1	1	1	3	3
CO8	3	3	3	3	3	3	2	2	3	3
CO9	3	3	3	3	3	3	1	1	1	1
CO10	3	3	3	3	3	3	1	1	1	1

Strong(3)Medium(2)andLow (1)

Paper-4-MATHEMATICALPHYSICS	IYEAR– SECONDSEMESTER

Subject Code	SubjectName	Category	L	T	P	Credits	Inst.Hours	Marks
23PHYC201	**MATHEMATICALPHYSICS**	Core	5	1		5	6	75

Pre-Requisites
Matrices,vectors,differentiation,integration,differentialequations
LearningObjectives
➢ To equip students with the mathematicaltechniques needed forunderstanding theoreticaltreatmentin differentcourses taughtin theirprogram ➢ Toextend theirmanipulativeskillsto applymathematicaltechniques intheir fields ➢ Tohelp students applyMathematics insolvingproblems of Physics

UNITS	CourseDetails
UNIT I: LINEARVECTORSPACE	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 – orthogonaltransformations and rotation.
UNITII: COMPLEXANALYSIS	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 – Parallelplates and coaxial cylinders
UNIT III:MATRICES	Typesof Matrices andtheir properties, Rank of a Matrix–Conjugateof amatrix - Adjoint of a matrix - Inverse of a matrix - Hermitian and UnitaryMatrices-Traceofamatrix-Transformationofmatrices-Characteristicequation-EigenvaluesandEigenvectors-Cayley–Hamiltontheorem–Diagonalization

UNIT IV:FOURIERTRANSFORMS &LAPLACE TRANSFORMS	Definitions-Fouriertransformanditsinverse-TransformofGaussianfunction and Dirac delta function -Fourier transform of derivatives - Cosineandsinetransforms-Convolutiontheorem.Application:Diffusionequation:Flowof heat in an infinite and in a semi - infinite medium - Waveequation:Vibrationofaninfinite stringand asemi-infinitestring.Laplace transform and its inverse Transforms of derivatives and integrals –Differentiationandintegrationoftransforms-Diracdeltafunctions-Application - Laplace equation: Potentialproblemina semi-infinitestrip
UNIT V:DIFFERENTIALEQUATIONS	Second order differential equation- Sturm-Liouville's theory - Series solutionwithsimpleexamples-Hermitepolynomials-Generatingfunction-Orthogonality properties - Recurrence relations – Legendre polynomials -Generating function - Rodrigue formula – Orthogonality properties - Diracdeltafunction-OnedimensionalGreen'sfunctionandReciprocitytheorem –Sturm-Liouville'stype equationin onedimension&theirGreen's function.
UNIT VI:PROFESSIONALCOMPONENTS	ExpertLectures,OnlineSeminars-WebinarsonIndustrialInteractions /Visits,CompetitiveExaminations,EmployableandCommunication Skill Enhancement,SocialAccountabilityandPatriotism
TEXTBOOKS	1. GeorgeArfkenandHans JWeber, 2012,Mathematical Methods forPhysicists–AComprehensiveGuide(7thedition),Academicpress. 2. P.K.Chattopadhyay,2013,*MathematicalPhysics*(2nd edition),NewAge,NewDelhi 3. AWJoshi,2017,MatricesandTensorsinPhysics,4thEdition(Paperback),NewAgeInternational Pvt. Ltd.,India 4. B.D.Gupta,2009,*MathematicalPhysics*(4th edition),Vikas PublishingHouse, NewDelhi. 5. H.K.DassandDr.RamaVerma,2014,MathematicalPhysics,SeventhRevisedEdition,S.Chand&CompanyPvt.Ltd.,New Delhi.
REFERENCEBOOKS	1. E. Kreyszig, 1983, Advanced Engineering Mathematics, WileyEastern, NewDelhi, 2. D. G. Zill and M. R. Cullen, 2006, Advanced Engineering Mathematics, 3rdEd. Narosa, NewDelhi. 3. S. Lipschutz, 1987, Linear Algebra, Schaum's Series, McGraw - Hill, NewYork 3. E. Butkov, 1968, Mathematical Physics Addison - Wesley, Reading,Massachusetts. 4. P.R.Halmos,1965,FiniteDimensionalVectorSpaces,2ndEdition,AffiliatedEast West, New Delhi. 5. C.R.Wylie andL.C. Barrett, 1995, Advanced EngineeringMathematics,6th Edition,InternationalEdition,McGraw-Hill,NewYork

WEBSOURCES	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_SlED56gNjVJGO2qaZ 5. https://archive.nptel.ac.in/courses/115/106/115106086/

COURSEOUTCOMES:

Attheend ofthecoursethestudent willbeableto:

CO1	Understanduseof bra-ketvectornotationand explain themeaning ofcompleteorthonormalsetofbasisvectors,andtransformationsandbeableto applythem	**K1, K2**
CO2	Abletounderstandanalyticfunctions,docomplexintegration,byapplyingCauchyIntegralFormula.Abletocomputemanyrealintegralsandinfinitesumsviacomplexintegration.	**K2, K3**
CO3	Analyze characteristics ofmatricesanditsdifferenttypes,andtheprocessofdiagonalization.	**K4**
CO4	SolveequationsusingLaplacetransformandanalyzetheFouriertransformations of different function, grasp how these transformations canspeedup analysis andcorrelatetheirimportanceintechnology	**K4, K5**
CO5	Tofindthesolutionsforphysicalproblemsusinglineardifferentialequations and to solve boundary value problems using Green's function.Applyspecial functions incomputation ofsolutionsto real worldproblems	**K2, K5**
K1-Remember; K2–Understand;K3-Apply;K4-Analyze;K5–Evaluate		

MAPPINGWITHPROGRAMOUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specificoutcomes**(PSO)** inthe 3-pointscaleofSTRONG(3),MEDIUM(2)andLOW(1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	3	3	3	3	3	2	3	2
CO2	2	3	3	3	3	3	3	2	2	2
CO3	3	3	3	2	2	3	3	2	3	2
CO4	3	3	3	3	2	3	3	2	2	2
CO5	3	2	3	3	2	3	3	2	2	3

Strong(3),Medium(2)andLow (1)

Paper5-QUANTUMMECHANICS–I	IYEAR-SECONDSEMESTER

Subject Code	SubjectName	Category	L	T	P	Credits	Inst.Hours	Marks
23PHYC202	**QUANTUMMECHANICS– I**	Core	5	1		5	6	75

Pre-Requisites
Newton'slawsofmotion,Schrodinger'sequation, integration,differentiation.
LearningObjectives
➢ Todevelopthephysicalprinciplesandthemathematicalbackgroundimportanttoquantummechanicaldescriptions. ➢ Todescribethepropagationofaparticleinasimple,one-dimensional potential. ➢ ToformulateandsolvetheSchrodinger'sequationtoobtaineigenvectorsandenergiesforparticleinathree-dimensional potential. ➢ Toexplainthemathematicalformalismandthesignificanceofconstantsofmotion,andseetheirrelation to fundamental symmetries in nature ➢ TodiscusstheApproximationmethodslikeperturbationtheory,VariationalandWKB methodsforsolvingtheSchrödingerequation.

UNITS	CourseDetails
UNIT I:BASICFORMALISM	Interpretation of the wave function – Time dependent Schrodinger equation –Time independentSchrodingerequation – Stationary states– Ehrenfest'stheorem – Linear vector space – Linear operator – Eigen functions and EigenValues–HermitianOperator– PostulatesofQuantumMechanics–Simultaneous measurabilityof observables – General Uncertaintyrelation
UNIT II: ONEDIMENSIONALAND THREE-DIMENSIONALENERGY EIGENVALUE PROBLEMS	Square – well potential with rigid walls –Squarepotentialbarrier– Alphaemission–Blochwavesinaperiodic potential – Kronig- Penny square – well periodic potential – Linearharmonicoscillator:Operatormethod– Particle movinginasphericallysymmetric potential – System of two interacting particles – Hydrogen atom –Rigid rotator
UNIT III:GENERALFORMALISM	Diracnotation–Equationsofmotions–Schrodingerrepresentation– Heisenbergrepresentation–Interactionrepresentation– Coordinaterepresentation–Momentumrepresentation– Symmetriesandconservationlaws–Unitarytransformation – Parityand timereversal

UNIT IV: APPROXIMATION METHODS	Time independent perturbation theory for non-degenerate energy levels – Degenerate energy levels – Stark effect in Hydrogen atom – Ground andexcited state – Variation method – Helium atom – WKB approximation –Connectionformulae(noderivation)–WKBquantization– Applicationtosimpleharmonicoscillator.
UNIT V:ANGULARMOMENTUM	Eigen value spectrum of general angular momentum – Ladder operators andtheir algebra – Matrixrepresentation – Spin angular momentum – Additionof angular momenta – CG Coefficients – Symmetry and anti – symmetry ofwavefunctions–Constructionofwave - functionsandPauli'sexclusionprinciple.
UNITVI: PROFESSIONAL COMPONENTS	Expert Lectures,OnlineSeminars-WebinarsonIndustrialInteractions/Visits,CompetitiveExaminations,EmployableandCommunication SkillEnhancement,SocialAccountabilityandPatriotism
TEXTBOOKS	1. P.M.MathewsandK.Venkatesan,ATextbookofQuantumMechanics,2nd edition (37thReprint),TataMcGraw-Hill, NewDelhi,2010. 2. G.Aruldhas,QuantumMechanics,2ndedition,PrenticeHallofIndia,NewDelhi,2009. 3. DavidJGriffiths,Introduction toQuantum Mechanics.4th edition,Pearson,2011. 4. SLGuptaandIDGupta,AdvancedQuantumTheoryandFields,1st Edition,S.Chand&Co., NewDelhi,1982. 5. A.GhatakandS.Lokanathan,QuantumMechanics:TheoryandApplications,4th Edition, Macmillan,India,1984.
REFERENCE BOOKS	1. E.Merzbacher,QuantumMechanics,2ndEdition,JohnWileyandSons, NewYork,1970. 2. V.K.Thankappan,QuantumMechanics,2ndEdition,WileyEasternLtd,NewDelhi, 1985. 3. L.D.LandauandE.M.Lifshitz,QuantumMechanics,1stedition,PergomonPress,Oxford,1976. 4. S.N.Biswas,QuantumMechanics,BooksandAlliedLtd.,Kolkata,1999. 5. V. Devanathan, Quantum Mechanics, 2nd edition, Alpha ScienceInternational Ltd,Oxford, 2011.
WEBSOURCES	1. http://research.chem.psu.edu/lxjgroup/download_files/chem565-c7.pdf 2. http://www.feynmanlectures.caltech.edu/III_20.html 3. http://web.mit.edu/8.05/handouts/jaffe1.pdf 4. https://hepwww.pp.rl.ac.uk/users/haywood/Group_Theory_Lectures/ Lecture_1.pdf 5. https://theory.physics.manchester.ac.uk/~xian/qm/chapter3.pdf

COURSEOUTCOMES:

Attheendof thecoursethestudent willbeableto:

CO1	Demonstratesa clear understandingof thebasicpostulates ofquantum mechanicswhichservetoformalizetherulesofquantum Mechanics	K1, K5
CO2	Isableto applyandanalyzetheSchrodingerequation tosolve one dimensionalproblemsand threedimensionalproblems	**K3, K4**
CO3	Candiscussthevariousrepresentations,spacetimesymmetriesand formulationsoftimeevolution	**K1**
CO4	Canformulateandanalyzetheapproximation methodsforvarious quantummechanicalproblems	**K4, K5**
CO5	Toapplynon-commutativealgebrafortopics suchasangularandspin angularmomentum andhence explainspectrallinesplitting.	**K3, K4**
K1-Remember; K2–Understand;K3-Apply;K4-Analyze;K5–Evaluate		

MAPPINGWITHPROGRAMOUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specificoutcomes**(PSO)** inthe 3-pointscaleofSTRONG(3),MEDIUM(2)andLOW(1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	3	3	3	2	3	2	2	3
CO2	3	3	3	3	3	S	3	2	2	3
CO3	2	3	3	2	3	2	3	2	2	3
CO4	3	3	3	3	3	2	3	3	2	3
CO5	3	3	3	2	3	S	3	3	2	3

Strong(3)Medium(2)andLow (1)

Paper-6 -PRACTICAL II	IYEAR-SECONDSEMESTER

Subject Code	SubjectName	Category	L	T	P	Credits	Inst.Hours	Marks
23PHYP203	**PRACTICALII**	Core			6	4	6	75

Pre-Requisites
Knowledgeandhandlingofbasicgeneralandelectronicsexperiments ofPhysics
LearningObjectives
➢ Tounderstandtheconceptofmechanicalbehaviorofmaterialsandcalculationofsameusingappropriate equations. ➢ Tocalculatethethermodynamicquantitiesandphysicalpropertiesof materials. ➢ Toanalyzetheopticalandelectricalpropertiesofmaterials. ➢ ToobservetheapplicationsofFETandUJT. ➢ Tostudythedifferentapplicationsofoperationalamplifiercircuits. ➢ TolearnaboutCombinationalLogicCircuitsandSequential LogicCircuits

CourseDetails

(AnyTwelveExperiments)

1. DeterminationofYoung‘smodulusandPoisson‘sratiobyEllipticalfringes-Cornu‘sMethod
2. MeasurementofSusceptibilityofliquid-Quincke‘smethod
3. MeasurementofMagneticSusceptibility-Guoy‘smethod
4. Arcspectrum: Copper
5. DeterminationofThicknessofthinfilm.-Michelson Interferometer
6. Molecularspectra– CN bands
7. DeterminationofRefractiveindexofliquidsusingdiodeLaser/He–NeLaser
8. HallEffectinSemiconductor.DeterminetheHallcoefficient,carrierconcentrationandcarriermobility
9. IC7490asscalarandsevensegmentdisplayusingIC7447
10. Solvingsimultaneousequations– IC741/ ICLM324
11. Op-Amp–Activefilters:Low pass,HighpassandBandpassfilters(SecondOrder)Batterworthfilter
12. ConstructionofCurrenttoVoltageandVoltagetoCurrentConversionusing IC741.
13. Constructionofsquarewave generatorusingIC 555 –StudyofVCO
14. ConstructionofSchmidttrigger circuitusingIC555foragivenhysteresis– Applicationassquarer

15. ConstructionofpulsegeneratorusingtheIC555–Applicationasfrequencydivider
16. Studyofbinaryup /down counters-IC7476 /IC7473
17. ShiftregisterandRingcounterandJohnsoncounter-IC7476/IC7474
18. Studyofsynchronousparallel 4-bitbinaryup/downcounterusingIC7493
19. Studyofasynchronousparallel4-bitbinaryup/downcounterusingIC7493
20. StudyofModulusCounter

TEXTBOOKS	1. PracticalPhysics,GuptaandKumar,PragatiPrakasan 2. KitDevelopedfordoingexperimentsinPhysics-Instructionmanual,R.SrinivasanK.RPriolkar,IndianAcademyofSciences 3. Op-Ampandlinearintegratedcircuit,RamakanthAGaykwad,EasternEconomyEdition. 4. ElectroniclabmanualVolI,KANavas,RajathPublishing 5. ElectroniclabmanualVolII,K ANavas,PHIeasternEconomyEdition
REFERENCE BOOKS	1.AnadvancedcourseinPracticalPhysics,D.Chattopadhayay,C.RRakshit, NewCentralBookAgencyPvt.Ltd 2. AdvancedPracticalPhysics,S.PSingh,PragatiPrakasan 3. AcourseonexperimentwithHe-NeLaser,R.S.Sirohi,JohnWiley&Sons(Asia)Pvt. ltd 4. ElectroniclabmanualVolII,KuriachanT.D,SyamMohan,AyodhyaPublishing 5. ElectronicLaboratoryPrimeradesignapproach,S.Poornachandra,B.Sasikala,WheelerPublishing,NewDelhi

COURSEOUTCOMES:

Attheend ofthecoursethestudent willbeableto:

CO1	UnderstandthestrengthofmaterialusingYoung‘smodulus	K2
CO2	Acquireknowledgeofthermalbehaviourofthematerials	K1
CO3	Understandtheoreticalprinciplesofmagnetismthroughtheexperiments.	K2
CO4	Acquireknowledgeabout arcspectrumandapplicationsoflaser	K1
CO5	ImprovetheanalyticalandobservationabilityinPhysicsExperiments	K4
CO6	Conductexperiments onapplicationsofFET andUJT	K5
CO7	Analyzevariousparametersrelatedtooperational amplifiers	K4
CO8	Understandtheconceptsinvolvedinarithmeticand logicalcircuits usingIC’s	K2
CO9	AcquireknowledgeaboutCombinationalLogicCircuitsandSequentialLogic Circuits	K3
CO10	Analyzetheapplicationsofcountersandregisters	K4
K1-Remember;K2–Understand;K3-Apply;K4-Analyze;K5–Evaluate		

MAPPINGWITHPROGRAMOUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specificoutcomes**(PSO)** inthe 3-pointscaleof STRONG(3), MEDIUM(2)andLOW(1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	2	2	2	S	S	2	2	2	3	3
CO2	2	2	S	S	S	2	2	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	2	3	3	3	3	2	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3
CO6	2	2	2	3	3	2	2	2	3	3
CO7	2	2	3	3	3	2	2	3	3	3
CO8	3	3	3	3	3	3	3	3	3	3
CO9	3	3	3	3	3	3	3	3	3	3
CO10	3	3	3	3	3	3	3	3	3	3

Strong(3)Medium(2)andLow (1)

Paper7-QUANTUMMECHANICS–II	II YEAR-THIRD SEMESTER

Subject Code	SubjectName	Category	L	T	P	Credits	Inst.Hours	Marks
23PHYC301	**QUANTUMMECHANICS–II**	Core	5	1		5	6	75

Pre-Requisites
KnowledgeofpostulatesofQuantummechanics, propertiesofHermitianoperators,ladderoperators,degeneracy, angularmomentum techniquesandcommutationrules
LearningObjectives
➢ Formaldevelopmentofthetheoryandthepropertiesofangularmomenta,bothorbitalandspin ➢ Tofamiliarizethestudentstothecrucialconceptsofscatteringtheorysuchaspartialwaveanalysisand Barn approximation. ➢ Time-dependentPerturbationtheoryanditsapplicationtostudyofinteractionofanatomwiththe electromagneticfield ➢ Togivethestudentsafirmgroundinginrelativisticquantummechanics,withemphasisonDiracequation and relatedconcepts ➢ To introduce the concept of covariance and the use of Feynman graphs for depicting differentinteractions

UNITS	CourseDetails
UNIT 1:SCATTERINGTHEORY	Scatteringamplitude–Crosssections–Bornapproximationanditsvalidity– Scattering by a screened coulomb potential – Yukawa potential – Partialwave analysis – Scattering length and Effective range theory for S wave –Opticaltheorem–Transformationfrom centreofmassto laboratoryframe.
UNIT II:PERTURBATIONTHEORY	Timedependentperturbationtheory–Constantandharmonicperturbations– FermiGoldenrule–TransitionprobabilityEinstein‘sAandBCoefficients – Adiabatic approximation – Sudden approximation – Semi – classicaltreatmentofanatomwithelectromagneticradiation– Selectionrulesfordipoleradiation

UNIT III:RELATISTICQUANTUM MECHANICS	Klein–GordonEquation–ChargeAndCurrentDensities–DiracMatrices–DiracEquation – PlaneWaveSolutions – Interpretation ofNegativeEnergyStates–Antiparticles–SpinofElectron–MagneticMomentofanElectronDueTo Spin
UNIT IV: DIRACEQUATION	Covariant form of Dirac Equation – Properties of the gamma matrices – Traces – Relativistic invariance of Dirac equation – Probability Density – Currentfourvector–Bilinearcovariant–Feynman'stheoryofpositron(Elementaryideasonlywithoutpropagation formalism)
UNIT V:CLASSICALFIELDSANDSECOND QUANTIZATION	Classical fields – Euler Lagrange equation – Hamiltonian formulation – Noether'stheorem–Quantizationofrealandcomplexscalarfields–Creation,AnnihilationandNumberoperators–Fockstates–SecondQuantizationofK-Gfield.
UNIT VI:PROFESSIONALCOMPONENTS	ExpertLectures,OnlineSeminars-WebinarsonIndustrialInteractions/Visits,CompetitiveExaminations,EmployableandCommunicationSkillEnhancement,SocialAccountabilityandPatriotism
TEXTBOOKS	1. P.M.MathewsandK.Venkatesan,ATextbookofQuantumMechanics, 2ndEdition,TataMcGraw-Hill,NewDelhi,2010. 2. G. Aruldhas, Quantum Mechanics, 2nd Edition, Prentice-Hall ofIndia,NewDelhi,2009 3. L.I.Schiff,QuantumMechanics,3rdEdition,InternationalStudentEdition,McGraw-HillKogakusha,Tokyo, 1968 4. V. Devanathan, Quantum Mechanics, 1st Edition, Narosa PublishingHouse,NewDelhi, 2005. 5. NouredineZettili,Quantummechanicsconceptsand applications,2ndEdition,Wiley, 2017
REFERENCEBOOKS	1. P.A.M.Dirac,ThePrinciplesofQuantumMechanics,4thEdition,OxfordUniversityPress, London, 1973. 2. B.K.Agarwal&HariPrakash,QuantumMechanics,7threprint,PHILearningPvt. Ltd.,New Delhi,2009. 3. DeepChandraJoshi,QuantumElectrodynamicsandParticlePhysics,1st edition,I.K.InternationalPublishinghousePvt. Ltd.,2006 4. GhatakandS.Lokanathan,QuantumMechanics:TheoryandApplications, 4th Edition,MacmillanIndia,NewDelhi. 5. E.Merzbacher,QuantumMechanics,2ndedition,JohnWileyandSons,NewYork, 1970
WEBSOURCES	1. https://ocw.mit.edu/courses/physics/8-05-quantum-physics-ii-fall-2013/lecturenotes/MIT8_05F13_Chap_09.pdf 2. http://www.thphys.nuim.ie/Notes/MP463/MP463_Ch1.pdf 3. http://hep.itp.tuwien.ac.at/~kreuzer/qt08.pdf 4. https://www.cmi.ac.in/~govind/teaching/rel-qm-rc13/rel-qm-notes-gk.pdf 5. https://web.mit.edu/dikaiser/www/FdsAmSci.pdf

COURSEOUTCOMES:

Attheend ofthecoursethestudent willbeableto:

CO1	Familiarizetheconcept ofscatteringtheorysuchaspartialwaveanalysisand Bornapproximation	K1
CO2	Giveafirmgroundingin relativisticquantummechanics,withemphasisonDiracequation and related concepts	K2
CO3	Discuss the relativistic quantum mechanical equations namely, Klein-Gordonand Diracequationsand thephenomena accountedbythem likeelectronspin and magneticmoment	K1, K4
CO4	Introducethe conceptof covarianceandtheuseofFeynman graphsfordepictingdifferent interactions	K1, K3
CO5	Demonstrateanunderstandingoffieldquantizationand theexplanationofthescatteringmatrix.	K5
K1-Remember;K2–Understand;K3 -Apply; K4-Analyze;K5-Evaluate		

MAPPINGWITHPROGRAMOUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specificoutcomes**(PSO)** inthe 3-pointscaleof STRONG(3), MEDIUM(2)andLOW(1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	3	3	3	3	3	3	3	3
CO2	3	3	2	3	3	3	3	3	3	3
CO3	3	2	2	3	3	2	3	3	3	3
CO4	2	1	1	3	3	1	2	2	3	3
CO5	2	1	1	3	3	2	2	2	3	3

Strong(3)Medium(2)andLow (1)

Paper8-CONDENSEDMATTERPHYSICS	**IIYEAR-THIRDSEMESTER**

Subject Code	**SubjectName**	**Category**	**L**	**T**	**P**	**Credits**	**Inst.Hours**	**Marks**
23PHYC302	**CONDENSEDMATTERPHYSICS**	Core	5	1		5	6	75

Pre-Requisites
Basicknowledgeofatomicphysics,quantummechanicsandstatistical mechanics.
LearningObjectives

- To describe variouscrystalstructures,symmetryandtodifferentiatedifferenttypesofbonding.
- Toconstructreciprocalspace,understandthelatticedynamicsandapplyittoconceptofspecificheat.
- Tocriticallyassessvarioustheoriesofelectronsinsolidsandtheirimpactindistinguishingsolids.
- Outlinedifferenttypesofmagneticmaterialsandexplaintheunderlyingphenomena.
- Elucidationofconceptsofsuperconductivity,theunderlyingtheories– relatetocurrentareasofresearch.

UNITS	CourseDetails
UNIT I: CRYSTALPHYSICS	Types of lattices - Miller indices – Symmetry elements and allowed rotations - Simple crystal structures – Atomic Packing Factor- Crystal diffraction - Bragg'slaw – Scattered Wave Amplitude - Reciprocal Lattice (sc, bcc, fcc). Structure andproperties of liquid crystals. Diffraction Conditions - Laue equations - Brillouinzone - Structure factor - Atomic form factor - Inert gas crystals - Cohesive energyofioniccrystals-Madelungconstant-Types ofcrystal binding(generalideas).
UNIT II:LATTICEDYNAMICS	Lattice with two atoms per primitive cell - First Brillouin zone - Group and phasevelocities - Quantization of lattice vibrations - Phonon momentum - Inelasticscatteringbyphonons-Debye'stheoryoflatticeheatcapacity– ThermalConductivity-Umkalapp processes.
UNIT III:THEORY OFMETALSAND SEMICONDUCTORS	Free electron gas in three dimensions - Electronic heat capacity - Wiedemann-Franz law - Band theory of metals and semiconductors - Bloch theorem - Kronig-Penney model - Semiconductors - Intrinsic carrier concentration – TemperatureDependence-Mobility-Impurityconductivity–Impuritystates- Hall effect - Fermi surfaces and construction - Experimental methods in Fermisurfacestudies-deHass-van Alpheneffect.
UNIT IV:MAGNETISM	Diamagnetism-Quantumtheoryofparamagnetism-Rareearth ion-Hund's rule-Quenchingoforbitalangularmomentum-Adiabaticdemagnetization-Quantumtheoryofferromagnetism- Curiepoint-Exchangeintegral-Heisenberg'sinterpretationofWeissfield-Ferromagneticdomains-Blochwall-Spinwaves-Quantization-Magnons-Thermalexcitationofmagnons-Curie temperature and susceptibility of ferrimagnets - Theory of Antiferromagnetism-Neel temperature.
UNITV: SUPERCONDUCTIVITY	**Experimental facts:** Occurrence - Effect of magnetic fields - Meissner effect – Criticalfield–Criticalcurrent-Entropyandheatcapacity-Energygap-Microwaveand infraredproperties-TypeIandIISuperconductors. **TheoreticalExplanation:**Thermodynamicsofsuperconductingtransition-London equation - Coherence length – Isotope effect - Cooper pairs – BardeenCooper Schrieffer (BCS) Theory – BCS to Bose – Einstein Condensation (BEC)regime-NatureofparingandcondensationofFermions.Singleparticletunneling-Josephsontunneling-DCandACJosephsoneffects-HightemperatureSuperconductors– SQUIDS.
UNIT VI:PROFESSIONAL COMPONENTS	ExpertLectures,OnlineSeminars-WebinarsonIndustrialInteractions/Visits,Competitive Examinations, Employable and Communication Skill Enhancement,SocialAccountabilityand Patriotism

TEXTBOOKS	1. C.Kittel,1996,*IntroductiontoSolidStatePhysics*,7th Edition,Wiley,NewYork . 2. RitaJohn,SolidStatePhysics,TataMc-GrawHillPublication. 3. A.J.Dekker,*SolidStatePhysics*,MacmillanIndia,NewDelhi. 4. M.Ali Omar,1974, *Elementary SolidStatePhysics–Principlesand Applications*,Addison - Wesley 5. H.P.Myers, 1998,*Introductory Solid StatePhysics*, 2nd Edition,VivaBook, NewDelhi.
REFERENCEBOOKS	1. J. S. Blakemore, 1974 ,*Solid statePhysics*, 2nd Edition,W.B. Saunder,Philadelphia 2. H. M. Rosenburg, 1993, *The Solid State*, 3rd Edition, Oxford UniversityPress,Oxford. 3. J.M.Ziman,1971,Principles*oftheTheoryofSolids*,CambridgeUniversit yPress,London. 4. C.Ross-InnesandE.H.Rhoderick,1976,*IntroductiontoSuperconductivity*,Pergamon, Oxford. 5. J. P. Srivastava, 2001, *Elements of Solid State Physics*, Prentice-Hall ofIndia,NewDelhi.
WEBSOURCES	1. http://www.physics.uiuc.edu/research/electronicstructure/389/389-cal.html 2. http://www.cmmp.ucl.ac.uk/%7Eaph/Teaching/3C25/index.html 3. https://www.britannica.com/science/crystal 4. https://www.nationalgeographic.org/encyclopedia/magnetism/ 5. https://www.brainkart.com/article/Super-Conductors_6824/

COURSEOUTCOMES:

Atthe end ofthecourse,the studentwillbeableto:

CO1	Studentwillbeabletolistoutthecrystalsystems,symmetriesallowedina systemandalsothediffractiontechniquestofindthecrystalstructure	**K1**
CO2	Studentswillbeabletovisualizetheideaofreciprocalspaces,BrillouinZoneand theirextensionto band theoryof solids.	**K1, K2**
CO3	Studentwillbeabletocomprehend theheatconduction in solids	**K3**
CO4	Studentwillbeabletogeneralizetheelectronicnatureofsolidsfrombandtheories.	**K3, K4**
CO5	Studentcancompareandcontrastthevarioustypesofmagnetismandconceptualizet heideaofsuperconductivity.	**K5**
K1-Remember; K2–Understand;K3 -Apply;K4-Analyze;K5–Evaluate		

MAPPINGWITHPROGRAMOUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and programspecificoutcomes**(PSO)**inthe3-pointscaleofSTRONG(3),MEDIUM(2)andLOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	2	3	2	2	2	2	2	2	2
CO2	3	2	3	2	3	2	3	3	2	3
CO3	3	3	3	2	3	2	3	3	2	3
CO4	2	2	2	2	2	2	2	2	2	3

CO5	2	2	2	2	2	2	2	2	2	3

Strong(3)Medium(2)andLow (1)

Paper9-ELECTROMAGNETICTHEORY	**IIYEAR-THIRD SEMESTER**

Subject Code	**SubjectName**	**Category**	**L**	**T**	**P**	**Credits**	**Inst.Hours**	**Marks**
23PHYC303	**ELECTROMAGNETICTHEORY**	Core	5	1		5	6	75

Pre-Requisites
Differentcoordinatesystems,Laplace‘sequation,conducting&non-conductingmedium,basic definitionsinmagnetism,propagationofelectromagneticwaves,plasma

LearningObjectives
➢ Toacquireknowledgeaboutboundaryconditionsbetweentwomediaandthetechniqueofmethodof separation ofvariables ➢ Tounderstand Biot–Savart‘slawand Ampere‘scircuitallaw ➢ TocomprehendthephysicalideascontainedinMaxwell‘sequations,Coulomb&Lorentzgauges,co nservation laws ➢ Toassimilatetheconceptsofpropagation,polarization,reflectionandrefractionofelectromag neticwaves ➢ Tograsptheconceptofplasmaasthefourth stateofmatter

UNITS	**CourseDetails**
UNIT I:ELECTROSTATICS	Boundary value problems and Laplace equation – Boundary conditions anduniquenesstheorem–Laplaceequationinthreedimension–SolutioninCartesian and spherical polar coordinates – Examples ofsolutions for boundaryvalueproblems. Polarizationanddisplacementvectors-Boundaryconditions-Dielectricsphereinauniformfield–Molecularpolarizability andelectricalsusceptibility– Electrostatic energy in the presence of dielectric – Multipoleexpansion.

UNIT II:MAGNETOSTATICS	Biot-Savart's Law - Ampere's law - Magnetic vector potential and magneticfield of a localized current distribution - Magnetic moment, force and torque ona current distribution in an external field - Magneto staticenergy-Magneticinductionandmagneticfieldinmacroscopic media-Boundaryconditions-Uniformlymagnetized sphere.
UNIT III:MAXWELLEQUATIONS	Faraday'slaws ofInduction- Maxwell'sdisplacementcurrent-Maxwell'sequations-Vectorandscalarpotentials-Gaugeinvariance-Waveequationandplanewavesolution-CoulombandLorentzgauges-Energyandmomentumofthefield-Poynting'stheorem-Lorentzforce–Conservationlawsforasystemof chargesandelectromagneticfields
UNITIV: WAVEPROPAGATION	Plane waves in non-conducting media - Linear and circular polarization,reflection and refraction at a plane interface - Waves in a conducting medium -Propagationof waves in arectangular waveguide.Inhomogeneouswave equationandretardedpotentials - Radiationfromalocalizedsource-Oscillatingelectricdipole
UNIT V:ELEMENTARY PLASMAPHYSICS	TheBoltzmannEquation-Simplifiedmagneto-hydrodynamicequations - Electron plasma oscillations - The Debye shielding problem - Plasmaconfinement in a magnetic field - Magneto-hydrodynamic waves-Alfvenwavesand magnetosonicwaves.
UNIT VI:PROFESSIONALCOMPONENTS	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits,CompetitiveExaminations,EmployableandCommunication SkillEnhancement,Social Accountabilityand Patriotism
TEXTBOOKS	*1.* D.J.Griffiths,2002,IntroductiontoElectrodynamics,3rdEdition,Prentice-Hall ofIndia,NewDelhi. *2.* J. R. Reitz, F. J. Milford and R. W. Christy, 1986, Foundations ofElectromagneticTheory,3rdedition,NarosaPublishingHouse, NewDelhi. *3.* J. D. Jackson, 1975, Classical Electrodynamics, Wiley Eastern Ltd. NewDelhi. *4.* J.A.Bittencourt,1988,FundamentalsofPlasmaPhysics, PergamonPress,Oxford. *5.* Gupta,Kumarand Singh,Electrodynamics,S.Chand&Co.,NewDelhi
REFERENCE BOOKS	1. W.PanofskyandM. Phillips, 1962,*ClassicalElectricityandMagnetism*,AddisonWesley,London. 2. J. D. Kraus and D. A. Fleisch, 1999, *Electromagnetics with Applications*, 5thEdition,WCBMcGraw-Hill, New York. 3. B. Chakraborty, 2002, *Principles of Electrodynamics*, Books and Allied,Kolkata. 4. P. Feynman, R. B. Leighton and M. Sands, 1998, *The Feynman Lectures onPhysics*,Vols. 2, NarosaPublishingHouse, NewDelhi. 5. AndrewZangwill,2013,ModernElectrodynamics,CambridgeUniversity Press, USA.

WEBSOURCES	1. http://www.plasma.uu.se/CED/Book/index.html 2. http://www.thphys.nuim.ie/Notes/electromag/frame-notes.html 3. http://www.thphys.nuim.ie/Notes/em-topics/em-topics.html 4. http://dmoz.org/Science/Physics/Electromagnetism/Courses_and_Tutorials/ 5. https://www.cliffsnotes.com/study-guides/physics/electricity-and-magnetism/electrostatics

COURSEOUTCOMES:

Attheend ofthecoursethestudent willbeableto:

CO1	SolvethedifferentialequationsusingLaplaceequationandtofindsolutionsfor boundaryvalueproblems	**K1, K5**
CO2	UseBiot-Savart'slawandAmperecircuitallawtofindthe magneticinduction& magneticvectorpotentialforvariousphysicalproblems	**K2, K3**
CO3	ApplyMaxwell'sequationstodescribehowelectromagneticfieldbehavesin differentmedia	**K3**
CO4	Apply the concept of propagation of EM waves through wave guides in opticalfiber communications and also in radar installations, calculate the transmissionandreflection coefficients of electromagneticwaves	**K3, K4**
CO5	Investigatetheinteractionofionizedgaseswithself-consistentelectricand magneticfields	**K5**
K1-Remember; K2–Understand;K3 -Apply;K4-Analyze;K5–Evaluate		

MAPPINGWITHPROGRAMOUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specificoutcomes**(PSO)** inthe 3-pointscaleof STRONG(3), MEDIUM(2)andLOW(1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	3	1	2	2	3	3	1	3
CO2	3	3	3	1	2	2	3	3	1	3
CO3	3	3	3	1	2	2	3	3	1	3
CO4	3	3	3	1	2	2	3	3	1	3
CO5	3	3	3	1	2	2	3	3	1	3

Strong(3)Medium(2)andLow (1)

Paper 10 - PRACTICAL III: MICROPROCESSOR 8085ANDMICROCONTROLLER 8051	**II YEAR-THIRD SEMESTER**

Subject Code	SubjectName	Category	L	T	P	Credits	Inst.Hours	Marks
23PHYP304	**PRACTICAL III:(MICROPROCESSOR8085 AND MICROCONTROLLER8051)**	Core			6	4	6	75

Pre-Requisites
Fundamentalsofdigital principles
LearningObjectives
➢ TounderstandthetheoryandworkingofMicroprocessor,Microcontrollerandtheirapplications ➢ TousemicroprocessorandMicrocontrollerindifferentapplications

CourseDetails

Practical III : MICROPROCESSOR 8085 AND MICROCONTROLLER 8051(ANYTWELVE EXPERIMENTS)

1. 8-bitadditionandsubtraction,multiplicationanddivision
2. SumofasetofNdata(8-bitnumber),pickingupthesmallestandlargestnumberinanarray. Sortingin ascendingand descendingorder
3. Codeconversion (8-bitnumber): a)BinarytoBCDb)BCDto binary
4. Additionofmultibytenumbers,Factorial
5. InterfacingofLED– Binaryup/downcounter,BCDup/downcounterandN/2Nup/downcounter
6. DAC0800/DAC1048interfaceandwave formgeneration(Unipolar/Bipolaroutput)
7. ADC0809interface
8. InterfacingofDCsteppermotor–Clockwise,Anti-clockwise,AngularmovementandWiperaction
9. TrafficLightController
10. Addition,Subtraction, MultiplicationandDivisionof8-bitnumbers.
11. Sumofaseriesof8-bit numbers
12. AverageofNnumbers
13. Factorialofnumber
14. FibonacciseriesofNterms
15. MultibyteAddition/SubtractionSorting
16. gin ascendingand descendingorder– Pickingupsmallest and largestnumber
17. DAC0800/1408interfaceandwaveformgeneration
18. ADCinterfacing
19. Steppermotorinterfacing
20. Trafficlightcontroller

TEXTBOOKS	1. Douglas V. Hall, Microprocessors and Interfacing programming andHardware,TataMcGraw Hill Publications (2008) 2. Muhammad Ali Mazidi, Janice GillispieMazidi, Rolin D. Mckinlay,The8051MicrocontrollerandEmbeddedSystems,PearsonEducation(2008). 3. V.Vijayendran,2005,Fundamentalsof Microprocessor-8085Ⅱ,3rdEdition S.Visvanathan Pvt,Ltd. 4. The8085Microprocessor,Architecture,ProgrammingandInterfacing– K. UdayaKumar,S.UmaShankar,Pearson 5. FundamentalsofMicroprocessorsandMicrocontrollers-B.Ram, DhanpatRaiPublications
REFERENCEBOOKS	1. W.A.Tribel, AvtarSingh,–The 8086/8088 Microprocessors: Programming,Interfacing,Software,HardwareandApplications,Prentice-Hall ofIndia,NewDelhi. 2. MicroprocessorandItsApplication-S.Malarvizhi,AnuradhaAgenciesPublications 3. MicroprocessorArchitecture,ProgramAndItsApplicationWith8085-R.S.Gaonkar, NewAgeInternational(P) Ltd 4. Barry B. Brey, 1995, The Intel Microprocessors 8086/8088, 80186,80286, 80386 and 80486, 3rd Edition, Prentice- Hall of India, NewDelhi. 5. J.Uffrenbeck,The8086/8088 Family-Design,Programming and Interfacing, Software, Hardware and Applications, Prentice-Hall ofIndia, NewDelhi.

METHODOFEVALUATION:

ContinuousInternal Assessment	**EndSemester Examination**	**Total**	**Grade**
25	**75**	**100**	

COURSEOUTCOMES:

Atthe endof thecourse,thestudentwill beableto:

CO1	Developtheprogrammingskills ofMicroprocessor	**K5**
CO2	AppreciatetheapplicationsofMicroprocessorprogramming	**K3**
CO3	Understandthe structure and workingof8085microprocessor and applyit.	**K1, K3**
CO4	Acquireknowledgeabouttheinterfacingperipherals with8085 microprocessor.	**K1, K4**
CO5	Acquireknowledgeabouttheinterfacing8051microcontroller withvarious peripherals.	**K1, K4**
K1-Remember;K2–Understand;K3-Apply;K4-Analyze;K5-Evaluate;		

MAPPINGWITHPROGRAMOUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specificoutcomes**(PSO)** inthe 3-pointscaleof STRONG(3), MEDIUM(2)andLOW(1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**

CO1	2	2	2	3	3	2	2	1	3	2
CO2	2	1	3	3	3	2	2	1	3	2
CO3	3	3	1	3	3	2	2	1	3	2
CO4	3	3	3	3	3	2	2	1	3	2
CO5	3	3	3	3	3	2	2	1	3	2

Strong(3)Medium(2)andLow (1)

Paper11-NUCLEAR ANDPARTICLEPHYSICS		**IIYEAR- FOURTHSEMESTER**						
Subject Code	**SubjectName**	**Category**	**L**	**T**	**P**	**Credits**	**Inst.Hours**	**Marks**
23PHYC401	**NUCLEARAND PARTICLEPHYSICS**	Core	5	1		5	6	75

Pre-Requisites

Knowledgeofbasicstructureofatom and nucleus.

LearningObjectives

- Introducesstudents tothedifferentmodels ofthenucleusinachronologicalorder
- Impartsanin-depthknowledgeonthenuclearforce,experimentstostudyitandthetypesofnuclear reactions and their principles
- Providesstudentswith detailsofnucleardecaywithrelevanttheories
- ExposesstudentstotheStandard ModelofElementaryParticlesand Higgsboson

UNITS	**CourseDetails**

UNITI: NUCLEARMODELS	Liquid drop model – Weizacker mass formula – Isobaric mass parabola – Mirror Pair - Bohr Wheeler theory of fission – shell model – spin-orbitcoupling – magic numbers – angular momenta and parity of ground states –magnetic moment – Schmidt model – electric Quadrapole moment - BohrandMottelson collectivemodel–rotational andvibrational bands.
UNITII: NUCLEARFORCES	Nucleon–nucleoninteraction–Tensorforces–propertiesof nuclearforces – ground state of deuteron – Exchange Forces - Meson theory of nuclearforces – Yukawa potential – nucleon-nucleon scattering – effective rangetheory –spindependenceofnuclearforces-chargeindependenceandchargesymmetry– isospin formalism.
UNITIII: NUCLEARREACTIONS	Kinds of nuclear reactions – Reaction kinematics – Q-value – Partial waveanalysisofscatteringandreactioncrosssection–scatteringlength– Compound nuclear reactions – Reciprocity theorem – Resonances – BreitWigneronelevelformula–Directreactions-NuclearChainreaction– fourfactorformula.
UNITIV: NUCLEARDECAY	Beta decay – Continuous Beta spectrum – Fermi theory of beta decay - Comparative Half-life –Fermi Kurie Plot – mass of neutrino – allowed andforbidden decay — neutrino physics – Helicity - Parity violation - Gammadecay – multipole radiations – Angular Correlation - internal conversion –nuclearisomerism– angularmomentumand parityselection rules.
UNITV: ELEMENTARY PARTICLES	ClassificationofElementaryParticles–TypesofInteractionandconservation laws – Families of elementary particles – Isospin – QuantumNumbers – Strangeness – Hypercharge and Quarks –SU (2) and SU (3)groups-Gell Mann matrices– Gell Mann Okuba Mass formula-Quark Model.Standardmodel ofparticlephysics–Higgsboson.
UNITVI: PROFESSIONAL COMPONENTS	ExpertLectures,OnlineSeminars – WebinarsonIndustrialInteractions/Visits,CompetitiveExaminations,EmployableandCommunication SkillEnhancement,SocialAccountabilityandPatriotism
TEXTBOOKS	1. D.C.Tayal –NuclearPhysics –Himalaya PublishingHouse(2011) 2. K.S.Krane–IntroductoryNuclearPhysics–JohnWiley&Sons(2008) 3. R.Royand P.Nigam–NuclearPhysics–NewAgePublishers(1996) 4. S. B. Patel – Nuclear Physics – An introduction – New Age InternationalPvtLtd Publishers (2011) 5. S.Glasstone –Source Bookof AtomicEnergy– VanNostrandReinholdInc.,U.S.-3rd Revisededition (1968)
REFERENCEBOOKS	1. L.J.Tassie–ThePhysicsofelementaryparticles–PrenticeHallPress(1973) 2. H.A.Enge–IntroductiontoNuclearPhysics– AddisonWesley,PublishingCompany.Inc.Reading.NewYork,(1974). 3. Kaplan–NuclearPhysics –1989 –2ndEd.–Narosa(2002) 4. BernardLCohen–ConceptsofNuclearPhysics– McGrawHillEducation(India)PrivateLimited; 1edition (2001) 5. B.L.Cohen,1971,Concepts ofNuclearPhysics, TMCH,NewDelhi.

WEBSOURCES	1. http://bubl.ac.uk/link/n/nuclearphysics.html 2. http://www.phys.unsw.edu.au/PHYS3050/pdf/Nuclear_Models.pdfhttp://www.scholarpedia.org/article/Nuclear_Forces 3. https://www.nuclear-power.net/nuclear-power/nuclear-reactions/ 4. http://labman.phys.utk.edu/phys222core/modules/m12/nuclear_models.html 5. https://www.ndeed.org/EducationResources/HighSchool/Radiography/radioactivedecay.html

COURSEOUTCOMES:
Atthe end ofthecourse,thestudentwillbeableto:

CO1	Gainknowledgeabouttheconcepts ofhelicity, parity,angularcorrelation andinternalconversion.	K1, K5
CO2	Demonstrate knowledge of fundamental aspects of the structure of thenucleus,radioactivedecay,nuclearreactions andtheinteractionof radiationandmatter.	K2, K3
CO3	Usethedifferentnuclear modelsto explaindifferentnuclearphenomena andtheconceptofresonancesthroughBriet-Weignersinglelevel formula	K3
CO4	Analyzedatafrom nuclearscatteringexperimentstoidentifydifferent propertiesofthenuclearforce.	K3, K4
CO5	Summarizeandidentifyallowedandforbiddennuclearreactionsbasedon conservationlawsof theelementaryparticles.	K5
K1-Remember;K2–Understand;K3-Apply;K4-Analyze;K5–Evaluate		

MAPPINGWITHPROGRAMOUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specificoutcomes**(PSO)** inthe 3-pointscaleof STRONG(3), MEDIUM(2)andLOW(1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	2	2	2	2	2	2	2	2
CO2	3	3	2	2	1	2	1	2	2	2
CO3	3	3	1	2	1	2	1	1	2	2
CO4	3	3	2	3	2	3	2	2	3	3
CO5	3	3	2	3	2	3	2	3	3	3

Strong(3)Medium(2)andLow (1)

Paper12-SPECTROSCOPY		**IIYEAR- FOURTH SEMESTER**						
Subject Code	**SubjectName**	**Category**	**L**	**T**	**P**	**Credits**	**Inst.Hours**	**Marks**

23PHYC402	**SPECTROSCOPY**	Core	5	1		5	6	75

Pre-Requisites

Thoroughunderstandingofelectromagneticspectrum,mathematicalabilities,knowledgeof molecules,theirstructure,bondnature,physical andchemicalbehavior

LearningObjectives

- Tocomprehendthetheorybehinddifferentspectroscopicmethods
- To know the working principles along with an overview of construction of different types ofspectrometersinvolved
- Toexplorevariousapplications ofthesetechniquesinR&D.
- Applyspectroscopictechniquesforthequalitativeandquantitativeanalysisofvariouschemic alcompounds.
- Understandthisimportantanalytical tool

UNITS	**CourseDetails**
UNITI: **MICROWAVESPECTROSCOPY**	Rotational spectra of diatomic molecules - Rigid Rotor (Diatomic Molecules)-reduced mass – rotational constant - Effect of isotopic substitution - Non rigidrotator – centrifugal distortion constant- Intensity of Spectral Lines- Polyatomicmolecules – linear – symmetric asymmetric top molecules - Hyperfine structureandquadrupolemomentoflinearmolecules-Instrumentationtechniques–blockdiagram-InformationDerivedfromRotationalSpectra-Starkeffect-Problems.
UNIT II:INFRAREDSPECTROSCOPY	Vibrationsofsimpleharmonicoscillator–zero-pointenergy-Anharmonicoscillator–fundamentals,overtonesandcombinations-DiatomicVibratingRotator- PR branch – PQR branch- Fundamental modes of vibration of H_2O andCO_2 -Introduction to application of vibrational spectra- IR SpectrophotometerInstrumentation(DoubleBeamSpectrometer)–FourierTransformInfraredSpectroscopy-Interpretationofvibrationalspectra–remoteanalysisofatmosphericgaseslikeN_2OusingFTIRbyNationalRemote SensingCentre(NRSC),India–othersimpleapplications
UNITIII: RAMANSPECTROSCOPY	TheoryofRamanScattering-Classicaltheory–molecularpolarizability–polarizability ellipsoid - Quantum theory of Raman effect - rotational Ramanspectraoflinearmolecule-symmetrictopmolecule–Stokesandanti-stokesline- SR branch -Raman activity of H_2O and CO_2.Mutual exclusion principle-determination of N_2O structure -Instrumentation technique and block diagram -structuredeterminationofplanarandnon-planarmoleculesusingIRandRamantechniques- FTRamanspectroscopy-SERS

UNITIV: RESONANCESPECTROSCOPY	NuclearandElectronspin-Interactionwithmagneticfield-PopulationofEnergy levels-Larmorprecession-Relaxationtimes- Double resonance-Chemicalshiftanditsmeasurement-NMRofHydrogennuclei-IndirectSpin-SpinInteraction–interpretationofsimpleorganicmolecules-Instrumentationtechniques of NMR spectroscopy – NMR in Chemical industries- MRI ScanElectronSpinResonance:Basicprinciple–TotalHamiltonian(DirectDipole-DipoleinteractionandFermiContactInteraction)–HyperfineStructure(Hydrogenatom)–ESRSpectraofFreeradicals–g-factors–Instrumentation-Medicalapplications ofESR
UNIT V: UVSPECTROSCOPY	Origin of UV spectra - Laws of absorption – Lambert Bouguer law – LambertBeer law - molar absorptivity – transmittance and absorbance - Color in organiccompounds-AbsorptionbyorganicMolecule-Chromophores-Effectofconjugationonchromophores-ChoiceofSolventandSolventeffect-Absorptionbyinorganicsystems-Instrumentation-doublebeamUV-Spectrophotometer-Simpleapplications
UNIT VI:PROFESSIONAL COMPONENTS	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits,CompetitiveExaminations,EmployableandCommunicationSkillEnhancement,Social Accountabilityand Patriotism
TEXTBOOKS	1. C.N.BanwellandEMMcCash,1994,FundamentalsofMolecularSpectroscopy,4thEdition, TataMcGraw–Hill, NewDelhi. 2. G.Aruldhas,1994,MolecularStructureand MolecularSpectroscopy,Prentice–Hall ofIndia, New Delhi. 3. D.N. Satyanarayana, 2001, *Vibrational Spectroscopy and Applications*,NewAgeInternational Publication. 4. B.K.Sharma,2015,*Spectroscopy*,GoelPublishingHouseMeerut. 5. Kalsi.P.S,2016,SpectroscopyofOrganicCompounds(7^{th}Edition),NewAgeInternational Publishers.
REFERENCEBOOKS	1. JLMcHale,2008,MolecularSpectroscopy,PearsonEducationIndia,New Delhi. 2. JMHollas,2002,BasicAtomicandMolecularSpectroscopy,RoyalSocietyof Chemistry, RSC, Cambridge. 3. B. P.StraughanandS.Walker,1976,SpectroscopyVol.I,ChapmanandHall, NewYork. 4. K.Chandra,1989,IntroductoryQuantumChemistry,TataMcGrawHill,NewDelhi. 5. Demtroder.W,LaserSpectroscopy:BasicconceptsandInstrumentation,SpringerLink.

WEBSOURCES	1. https://www.youtube.com/watch?v=0iQhirTf2PI 2. https://www.coursera.org/lecture/spectroscopy/introduction-3N5D5 3. https://www.coursera.org/lecture/spectroscopy/infrared-spectroscopy-8jEee 4. https://onlinecourses.nptel.ac.in/noc20_cy08/preview 5. https://www.coursera.org/lecture/spectroscopy/nmr-spectroscopy-introduction-XCWRu

COURSEOUTCOMES:

Attheend ofthecoursethestudent willbeableto:

CO1	Understandfundamentalsofrotationalspectroscopy,viewmoleculesaselastic rotors and interpret their behaviour. Able to quantify their natureandcorrelate them withtheircharacteristicproperties.	**K2**
CO2	Understand the working principles of spectroscopic instruments andtheoreticalbackgroundofIRspectroscopy. Abletocorrelatemathematicalprocessof Fouriertransformationswithinstrumentation.Abletointerpret vibrationalspectrumofsmallmolecules.	**K2, K3**
CO3	Interpretstructuresandcompositionofmoleculesandusetheir knowledgeofRaman Spectroscopyasanimportantanalyticaltool	**K5**
CO4	Usetheseresonancespectroscopictechniquesfor quantitativeand qualitativeestimation ofasubstances	**K4**
CO5	Learntheelectronictransitionscaused byabsorption ofradiation inthe UV/Visregionoftheelectromagneticspectrum and beabletoanalyzeasimpleUVspectrum.	**K1, K5**
K1-Remember;K2–Understand;K3-Apply;K4-Analyze;K5-Evaluate		

MAPPINGWITHPROGRAMOUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specificoutcomes**(PSO)** inthe 3-point scaleofSTRONG(3), MEDIUM(2)andLOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	3	2	3	3	3	3	3	2
CO2	2	2	2	3	3	3	3	3	3	2
CO3	3	2	3	3	3	3	3	3	3	3
CO4	3	2	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3

Strong(3)Medium(2)andLow (1)

DEPARTMENTELECTIVECOURSES

Elective–1 . MATERIALSSCIENCE	**IYEAR- FIRST SEMESTER**

Subject Code	SubjectName	Category	L	T	P	Credits	Inst.Hours	Marks
23PHYE104	**MATERIALSSCIENCE**	ELECTIVE	4	1		3	5	75

Pre-Requisites
➢ Basicknowledgeondifferenttypesofmaterials
LearningObjectives
➢ Togainknowledgeonoptoelectronicmaterials ➢ Tolearnaboutceramicprocessingandadvancedceramics ➢ Tounderstandtheprocessingandapplicationsofpolymericmaterials ➢ Togainknowledgeonthefabricationofcompositematerials ➢ Tolearnaboutshapememoryalloys,metallicglassesandnanomaterials

UNITS	Coursedetails
UNIT I:OPTOELECTRONICMATERIALS	Importanceofopticalmaterials–properties:Bandgapandlatticematching – optical absorption and emission – charge injection, quasi-Fermilevelsandrecombination– opticalabsorption,lossandgain.Opticalprocessesinquantumstructures:Inter-bandandintra-bandtransitionsOrganicsemiconductors.Lightpropagationinmaterials– Electro-optic effect and modulation, electro-absorption modulation – excitonquenching.
UNIT IICERAMIC MATERIALS	Ceramicprocessing:powderprocessing,millingandsintering– structuralceramics:zirconia,almina,siliconcarbide,tungstencarbide– electronicceramics–refractories– glassandglassceramics
UNIT IIIPOLYMERICMATERIALS	Polymers and copolymers – molecular weight measurement – synthesis:chaingrowthpolymerization–polymerizationtechniques– glasstransitiontemperatureanditsmeasurement–viscoelasticity–polymer processing techniques – applications: conducting polymers, biopolymersandhigh temperaturepolymers.
UNIT IVCOMPOSITEMATERIALS	Particlereinforcedcomposites–fiberreinforcedcomposites– mechanicalbehavior– fabricationmethodsofpolymermatrixcompositesandmetalmatrixcomposites–carbon/carboncomposites: fabricationandapplications.
UNITV:NEW MATERIALS	Shapememoryalloys:mechanismsofone-wayandtwo-wayshapememory effect,reversetransformation,thermo-elasticity andpseudo-elasticity, examples and applications -bulk metallic glass: criteria forglassformationandstability,examplesandmechanicalbehavior-nanomaterials:classification,sizeeffectonstructuralandfunctional properties, processing and properties of Nano crystalline materials,singlewalled and multi walledcarbonnanotubes

UNIT VI:PROFESSIONALCOMPONENTS	Expert Lectures, OnlineSeminars – WebinarsonIndustrialInteractions/Visits, CompetitiveExaminations,EmployableandCommunicationSkillEnhancement,SocialAccountabilityandPatriotism
TEXTBOOKS	1. Jasprit Singh, Electronic and optoelectronic properties 2. P.K.Mallick.Fiber-ReinforcedComposites. CRCPress,2008. 3. V.Raghavan,2003,MaterialsScienceandEngineering,4th Edition ,Prentice-HallIndia,NewDelhi(Forunits2,3,4and5) 4. G.K.Narula,K.S.NarulaandV.K.Gupta,1988,MaterialsScience ,TataMcGraw-Hill 5. M.Arumugam,2002,MaterialsScience,3rd revisedEdition,Anur athaAgencies
REFERENCE BOOKS	1. B.S.Murty,P.Shankar,B.Raj,B.B.RathandJ.Murday.Textbook of Nanoscience and Nanotechnology. Springer- Verlag,2012. 2. K. Yamauchi, I. Ohkata, K. Tsuchiya and S. Miyazaki (Eds). ShapeMemoryandSuperElasticAlloys:TechnologiesandApplications.Wood headPublishing Limited, 2011. 3. Lawrence H. Van Vlack, 1998. Elements of Materials Science andEngineering,6th Edition,Second ISEreprint,Addison-Wesley. 4. H. Iabch and H. Luth, 2002, Solid State Physics – An IntroductiontoPrinciplesof MaterialsScience,2nd Edition,Springer. 5. D.Hull&T.W.Clyne,Anintroductionto compositematerials,Cambridge UniversityPress, 2008.
WEBSOURCES	1. https://onlinecourses.nptel.ac.in/noc20_mm02/preview 2. https://nptel.ac.in/courses/112104229 3. https://archive.nptel.ac.in/courses/113/105/1131050 814.https://nptel.ac.in/courses/113/105/113105025/ https://eng.libretexts.org/Bookshelves/Materials_Science/Supplemental_M odules_(Materials_Science)/Electronic_Properties/Lattice_Vibrations

COURSEOUTCOMES:
Atthe end ofthecourse,the studentwillbeableto:

CO1	Acquireknowledgeon optoelectronicmaterials	**K1**
CO2	Beabletoprepareceramicmaterials	**K3**
CO3	Beabletounderstandthe processingandapplicationsofpolymericmaterials	**K2, K3**
CO4	Beawareofthefabricationofcompositematerials	**K5**

CO5	Beknowledgeableofshapememoryalloys,metallicglassesandnano materials	**K1**
K1-Remember;K2–Understand;K3-Apply;K4-Analyze;K5-Evaluate;		

MAPPINGWITHPROGRAMOUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specificoutcomes**(PSO)** inthe 3-pointscaleof STRONG(3), MEDIUM(2)andLOW(1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	2	3	3	2	2	2	2	1	2	3
CO2	2	3	3	2	2	2	2	1	2	2
CO3	2	3	2	2	2	2	2	2	2	2
CO4	1	3	2	3	2	3	2	2	2	2
CO5	2	3	2	2	2	2	2	2	2	2

Strong(3)Medium(2)andLow (1)

Elective–2.DIGITALCOMMUNICATION		**IYEAR- FIRST SEMESTER**						
Subject Code	**SubjectName**	**Category**	**L**	**T**	**P**	**Credits**	**Inst.Hours**	**Marks**
23PHYE104	**DIGITALCOMMUNICATION**	ELECTIVE	4	1		3	5	75

Pre-Requisites
ExposuretoFouriertransform, pulsemodulation,multiplexing,noisesincommunication signals
LearningObjectives
➢ TounderstandtheuseofFourier,transforminanalyzingthesignals ➢ Tolearnaboutthequantaoftransmissionofinformation ➢ Tomakestudents familiarwithdifferenttypes of pulsemodulation ➢ Tohaveanin depthknowledgeabout thevariousmethodsof errorcontrollingcodes ➢ Toacquireknowledgeaboutspreadspectrumtechniquesingettingsecuredcommunication

UNITS	**CourseDetails**
UNIT I:SIGNAL ANALYSIS	Fouriertransformsofgatefunctions,deltafunctionsattheorigin–Two deltafunctionandperiodicdeltafunction–PropertiesofFouriertransform – Frequency shifting –Time shifting - Convolution – Graphicalrepresentation–Convolutiontheorem–TimeConvolutiontheorem– FrequencyConvolutiontheorem –Samplingtheorem.

UNIT II:INFORMATIONTHEORY	Communication system – Measurement of information – Coding – BandotCode CCITT Code –Hartley Law – Noise in an information CarryingChannel-Effectsofnoise-Capacity ofnoiseinachannel– ShannonHartleytheorem –Redundancy.
UNIT III:PULSEMODULATION	Pulse amplitude modulation - natural sampling – Instantaneous sampling - Transmission of PAM Signals -Pulse width modulation – Time divisionmultiplexing – Band width requirements for PAM Signals. Pulse CodeModulation–PrinciplesofPCM–Quantizingnoise–Generationand demodulation of PCM -Effects of noise –Companding – Advantages andapplication
UNIT IV:ERROR CONTROL CODING	IntroductiontoLinearBlockCodes,HammingCodes,BCHCoding,RSCoding, Convolutional Coding, CodingGrain Viterbi Coding
UNIT V:SPREADSPECTRUM SYSTEMS	PseudoNoisesequences,generationandCorrelationproperties,directsequence spread spectrum systems, frequency HOP Systems, processinggain,anti-jam and multipath performance
UNITVI: PROFESSIONAL COMPONENTS	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and CommunicationSkillEnhancement,SocialAccountabilityandPatriotism

TEXT BOOKS	1. B.P. Lathi, *Communicationsystem*,WileyEastern. 2. George Kennedy, *Electronic Communication Systems*, 3rd Edition,Mc GrawHill. 3. SimonHaykin,*CommunicationSystem*,3rdEdition,JohnWiley&Sons. 4. GeorgeKennedyandDavis,1988,*ElectronicCommunicationSystem*,TataMcGraw Hill4th Edition. 5. TaubandSchilling,1991,*"PrinciplesofCommunicationSystem"*,Second editionTataMcGraw Hill.
REFERENCE BOOKS	1. John Proakis, 1995, *Digital Communication*, 3rd Edition, McGraw Hill,Malaysia. 2. M. K. Simen, 1999, *Digital Communication Techniques, Signal Design andDetection*,Prentice HallofIndia. 3. DennisRoddyandCoolen,1995,*Electronicscommunications*,PrenticeHallofIndiaIV Edition. 4. Wave Tomasi, 1998, *"Advanced Electronics communication System"* 4thEditionPrenticeHall,Inc. 5. M.Kulkarni, 1988, *"Microwave and Radar Engineering",* UmeshPublications.
WEBSOURCES	1. http://nptel.iitm.ac.in/ 2. http://web.ewu.edu/ 3. http://www.ece.umd.edu/class/enee630.F2012.html 4. http://www.aticourses.com/Advanced%20Topics%20in%20Digital%20Signals 5. http://nptel.iitm.ac.in/courses/117101051.html

COURSEOUTCOMES:

Atthe end of thecourse,thestudentwillbeableto:

CO1	ApplythetechniquesofFouriertransform,convolutionandsamplingtheoremsinsignalprocessing	**K1, K3**
CO2	Applydifferentinformationtheories in theprocessof studyofcodingofinformation,storageandcommunication	**K3**
CO3	Explainandcomparethevarious methodsof pulsemodulationtechniques	**K4**
CO4	Applytheerrorcontrolcodingtechniquesindetectingandcorrectingerrors-abletodiscuss,analyzeand comparethedifferenterrorcontrol coding	**K3, K4**
CO5	Apply,discussandcomparethe spreadspectrumtechniquesforsecurecommunications	**K3,k5**
K1-Remember;K2–Understand;K3-Apply;K4-Analyze;K5-Evaluate;		

MAPPINGWITHPROGRAMOUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specificoutcomes**(PSO)** inthe 3-pointscaleof STRONG(3), MEDIUM(2)andLOW(1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	3	1	2	2	3	2	2	3
CO2	3	3	3	1	2	2	3	2	2	3
CO3	3	3	3	1	2	2	3	2	2	3
CO4	3	3	3	1	2	2	3	2	2	3
CO5	3	3	3	1	2	2	3	2	2	3

Strong(3)Medium(2)andLow (1)

Elective – 3. **COMMUNICATION ELECTRONICS**	**IYEAR- FIRST SEMESTER**

Subject Code	SubjectName	Category	L	T	P	Credits	Inst.Hours	Marks
23PHYE104	**COMMUNICATION ELECTRONICS**	ELECTIVE	4	1		3	5	75

Pre-Requisites
KnowledgeofRegionsofelectromagneticspectrumanditscharacteristics

LearningObjectives
➢ Tocomprehendthetransmissionofelectromagneticwavesthoroughdifferenttypesofantenna and also to acquire knowledge about the propagation of waves through earth‘satmosphereandalongthesurfaceof theearth ➢ Togainknowledgeinthegeneration andpropagation ofmicrowaves ➢ Toacquireknowledgeaboutradarsystemsanditsapplicationsandalsotheworkingprincipleofcolour television ➢ Tolearntheworkingprincipleoffiber opticsanditsuseintelecommunication ➢ Tounderstandthe generaltheoryandoperationofsatellitecommunicationsystems

UNITS	CourseDetails
UNITI: ANTENNASAND WAVE PROPAGATION	Radiationfieldandradiationresistanceofshortdipoleantenna-groundedantenna-ungroundedantenna-antennaarrays-broadsideandend side arrays-antenna gain-directional high frequency antennas-skywave – ionosphere- Ecles and Larmor theory- Magnento ionic theory-ground wavepropagation
UNIT II:MICROWAVES	Microwavegeneration - multicavityKlystron-reflexklystron-magnetron travelling wave tubes (TWT) and other microwave tubes-MASER-Gunndiode-waveguides-rectangularwaveguides-standingwaveindicatorand standingwaveratio (SWR)
UNIT III:RADAR ANDTELEVISION	Elementsofaradarsystem-radarequation-radarperformanceFactors radartransmittingsystems-radarantennas-duplexers-radarreceiversand indicators-pulsedsystems-otherradarsystems-colourTVtransmissionandreception-colourmixingprinciple-colourpicturetubes-Deltagunpicturetube-PILcolourpicturetube-cableTV,CCTV and theater TV
UNIT IV:OPTICALFIBER	Propagationoflightinanopticalfibre-acceptanceangle-numericalaperture-stepandgradedindexfibres-opticalfibresasacylindricalwave guide-wave guide equations-wave guide equations in step indexfibres-fibrelossesand dispersion-applications
UNIT V:SATELLITECOMMUNICATION	Orbitalsatellites-geostationarysatellites-orbitalpatterns-satellitesystemlinkmodels-satellitesystemparameters-satellitesystemlinkequationlink budget-INSATcommunication satellites
UNITVI: PROFESSIONAL	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and

COMPONENTS	Communication Skill Enhancement, Social Accountability and Patriotism
TEXTBOOKS	1. HandbookofElectronicsbyGuptaandKumar, 2008edition. 2. Electroniccommunicationsystems– GeorgeKennedyandDavis,TataMcGrawHill,4th edition, 1988. 3. Taub and Schilling, principles of communication systems, secondedition,Tata McGraw Hill (1991). 4. M. Kulkarani, Microwave and radar engineering,UmeshPublications,1998. 5. MonoChromeandcolour television,R. R.Ghulathi
REFERENCE BOOKS	1. Electroniccommunications–DennisRoodyandCoolen,PrenticeHall ofIndia,IVedition, 1995. 2. WayneTomasi,Advancedelectronicscommunicationsystems,fourthedition,PrenticeHall ofIndia,1998 *3.* DennisRoddyandCoolen,1995,*Electronicscommunications,* PrenticeHallofIndiaIVEdition. *4.* WayneTomasi,1998*"AdvancedElectronicscommunicationSystem"* 4th edition,PrenticeHallofIndia,1998 5. S.Salivahanan,N.SuershKumar&A.Vallavaraj,2009,ElectronicDevicesandCircuits,TataMcGraw-HillPublishingCompany Limited,NewDelhi,SecondEdition.
WEBSOURCES	1. https://www.geeksforgeeks.org/digital-electronics-logic-design-tutorials/ 2. https://www.polytechnichub.com/difference-analog-instruments-digital-instruments/ 3. http://nptel.iitm.ac.in/ 4. http://web.ewu.edu/ 5. http://nptel.iitm.ac.in/

COURSEOUTCOMES:

Atthe end ofthecourse,the studentwillbeableto:

CO1	Discuss andcomparethepropagationofelectromagneticwavesthroughskyand onearth'ssurfaceEvaluatetheenergyandpowerradiatedbythedifferenttypesofantenna	**K1, K5**
CO2	Compareanddifferentiatethemethodsofgenerationofmicrowavesanalyze thepropagationofmicrowavesthroughwaveguides-discussandcomparethedifferentmethodsofgenerationofmicrowaves	**K4**
CO3	Classifyandcomparetheworkingofdifferentradarsystems-applytheprincipleofradarindetectinglocating,tracking,andrecognizingobjectsof variouskindsatconsiderabledistances–discusstheimportanceofradarinmilitary-elaborateand comparetheworkingofdifferent picturetube	**K3**
CO4	Classify,discussandcomparethedifferenttypesofopticalfiberandalsoto justifytheneedof it-discovertheuse ofoptical fiberaswaveguide	**K1, K3**
CO5	Explaintheimportanceofsatellitecommunicationinourdailylife-distinguish betweenorbitalandgeostationary satellites elaboratethelinking ofsatelliteswithgroundstationon theearth	**K4**
K1-Remember;K2–Understand;K3-Apply;K4-Analyze;K5-Evaluate;		

MAPPINGWITHPROGRAMOUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specificoutcomes**(PSO)** inthe 3-pointscaleof STRONG(3), MEDIUM(2)andLOW(1)**.**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	1	2	2	3	2	1	3
CO2	3	3	3	1	2	2	3	2	1	3
CO3	3	3	3	1	2	2	3	2	1	3
CO4	3	3	3	1	2	2	3	2	1	3
CO5	3	3	3	1	2	2	3	2	1	3

Strong(3)Medium(2)andLow (1)

Elective–4.ENERGY PHYSICS	**IYEAR-FIRST SEMESTER**

Subject Code	**SubjectName**	**Category**	**L**	**T**	**P**	**Credits**	**Inst.Hours**	**Marks**
23PHYE105	**ENERGY PHYSICS**	ELECTIVE	4	1		3	5	75

Pre-Requisites
Knowledgeofconventionalenergyresources
LearningObjectives
➢ Tolearnaboutvariousrenewableenergysources. ➢ Toknow thewaysof effectivelyutilizingtheoceanic energy. ➢ To studythe method of harnessingwind energyand itsadvantages. ➢ Tolearnthetechniquesusefulforthe conversionofbiomassintousefulenergy. ➢ Toknowaboututilization ofsolarenergy.

UNITS	**CourseDetails**
UNIT I:INTRODUCTIONTO ENERGYSOURCES	Conventionalandnon-conventionalenergysourcesandtheiravailability– prospects of Renewable energy sources– Energy from other sources– chemical energy–Nuclear energy–Energystorageand distribution.
UNIT II:ENERGY FROMTHEOCEANS	Energy utilization–Energyfromtides–Basicprincipleoftidalpower– utilizationoftidalenergy–Principleofoceanthermalenergyconversion systems.
UNIT III:WINDENERGY SOURCES	Basic principles of wind energy conversion–power in the wind–forces intheBlades–Windenergyconversion–Advantagesand disadvantagesof windenergyconversionsystems(WECS)-Energystorage–Applicationsofwind energy.

UNIT IV:ENERGY FROMBIOMASS	Biomass conversion Technologies– wet and dry process– Photosynthesis - BiogasGeneration:Introduction– basicprocess:Aerobicandanaerobicdigestion– Advantagesofanaerobicdigestion– factorsaffectingbiodigestionandgeneration ofgas-biogasfrom wastefuel– propertiesof biogas-utilizationofbiogas.
UNIT V:SOLARENERGY SOURCES	Solarradiation anditsmeasurements– solarcells:Solarcellsfordirectconversion of solar energy to electric powers– solar cell parameter–solarcellelectricalcharacteristics–Efficiency– solarwaterHeater–solardistillation–solarcooking–solargreenhouse– Solarpondanditsapplications.
UNIT VI:PROFESSIONALCOMPONENTS	ExpertLectures,OnlineSeminars-WebinarsonIndustrialInteractions/Visits,CompetitiveExaminations,EmployableandCommunicationSkillEnhancement,SocialAccountabilityandPatriotism

TEXT BOOKS	1. G.D. Rai, 1996, Non – convention sources of, 4th edition, Khannapublishers,NewDelhi. 2. S.RaoandDr.ParuLekar,Energytechnology. 3. M.P.Agarwal,SolarEnergy,S.ChandandCo.,NewDelhi(1983). 4. Solarenergy,principlesofthermalcollectionandstoragebyS. P.Sukhatme, 2nd edition,TataMcGraw-HillPublishingCo.Lt.,NewDelhi(1997). 5. EnergyTechnologybyS.Rao andDr.Parulekar.
REFERENCE BOOKS	1. Renewableenergyresources,JohnTwidellandTonyweir,Taylor andFrancis group,Londonand NewYork. 2. Appliedsolarenergy,A.B. MeinelandA.P.Meinal 3. JohnTwidellandTonyWeir,Renewableenergyresources, Taylor andFrancis group,Londonand NewYork. 4. RenewalEnergyTechnologies:APracticalGuideforBeginnersC.S.Solanki-PHILearning 5. IntroductiontoNon-ConventionalEnergyResources-Rajaet.al.,Sci.TechPublications
WEBSOURCES	1. https://www.open.edu/openlearn/ocw/mod/oucontent/view.php?id=2411&printable=1 2. https://www.nationalgeographic.org/encyclopedia/tidal-energy/ 3. https://www.ge.com/renewableenergy/wind-energy/what-is-wind-energy 4. https://www.reenergyholdings.com/renewable-energy/what-is-biomass/ 5. https://www.acciona.com/renewable-energy/solar-energy/

COURSE OUTCOMES:

Atthe end ofthecourse,the studentwillbeableto:

CO1	Toidentifyvariousforms ofrenewableand non-renewableenergysources	**K1**
CO2	Understandthe principleof utilizingtheoceanicenergyand applyitfor practicalapplications.	**K2**
CO3	Discusstheworkingofawindmillandanalyzetheadvantagesofwindenergy.	**K3**
CO4	Distinguishaerobicdigestionprocessfromanaerobicdigestion.	**K3, K4**

CO5	Understandthe components ofsolarradiation,theirmeasurementandapply themtoutilizesolarenergy.	**K2, K5**
K1-Remember;K2–Understand;K3-Apply;K4-Analyze;K5-Evaluate;		

MAPPINGWITHPROGRAMOUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specificoutcomes**(PSO)** inthe 3-pointscaleof STRONG(3), MEDIUM(2)andLOW(1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	2	3	3	3	2	2	2	3	3	3
CO2	2	3	3	3	2	2	2	3	3	3
CO3	2	3	3	3	2	2	2	3	3	3
CO4	2	3	3	3	2	2	2	3	3	3
CO5	2	3	3	3	2	2	2	3	3	3

Strong(3)Medium(2)andLow (1)

Elective–5.BIO PHYSICS	**IYEAR-FIRST SEMESTER**

Subject Code	**SubjectName**	**Category**	**L**	**T**	**P**	**Credits**	**Inst.Hours**	**Marks**
23PHYE105	**BIOPHYSICS**	ELECTIVE	4	1		3	5	75

Pre-Requisites
Fundamentalconceptsof PhysicsandBiology
LearningObjectives
➢ Tounderstandthephysicalprinciplesinvolved incellfunctionmaintenance. ➢ Tounderstandthefundamentalsofmacromolecularstructuresinvolvedinpropagationoflife. ➢ Tounderstandthebiophysicalfunctionofmembraneandneuron. ➢ Tounderstandvariouskindsofradiationandtheireffectsonlivingsystemandtoknowthehazardspo sed bysuch radiations and therequiredprecautions. ➢ Tounderstandthephysicalprinciplesbehindthevarioustechniquesavailablefor interrogatingbiologicalmacromolecules.

UNITS	**CourseDetails**
UNIT I:CELLULARBIOPHYSICS	ArchitectureandLifeCycleofcells–OrganellesofProkaryoticandEukaryotic cell – Cell size and shape – Fine structure of Prokaryotic andEukaryoticcellorganization–Compartment&assembliesmembranesystem – Extracellular matrix - Molecular mechanisms of Vesicular traffic - Electrical activities ofcardiacand neuronalcells.

UNIT II:MOLECULARBIOPHYSICS	Macromolecularstructure:Proteinstructure–aminoacids,peptidebonds,primary,secondary, tertiaryand quaternarystructures ofproteins Nucleicacidstructure:nucleosidesandnucleotides,RNAstructure,DNAstructureandconformation. SpecialBio-macromolecules:Metalloproteins,nucleoproteins,ribozymes,chaperonsand prions.
UNIT III:MEMBRANEANDNEUROBIOPHYISCS	Modelsmembranes-Biological membranesand dynamics–MembraneCapacitors – Transport across cell and organelle membranes –Ion channels.Nervoussystem:Organizationofthenervoussystem–Membranepotential –Originsofmembranepotential-Electrochemicalpotentials–Nernstequation–Goldman equation.
UNIT IV:RADIATION BIOPHYSICS	X-Ray:Effectsonbio-macromolecules–GammaRadiation:Molecularеffectsofgammaradiation,Radiationeffectsonnucleicacidsandmembranes,Effectsoncellandorganelles–UVradiation:Effectsonbio-macromoleculesandproteins–Radiationhazardsandprotection–useofradiationsin cancer.
UNIT V:PHYSICALMETHODS INBIOLOGY	Spectroscopy:UV-Visibleabsorptionspectrophotometry–OpticalRotatoryDispersion(ORD)–StructureDetermination:X-rayCrystallography,Electronspinresonance(ESR)andbiologicalapplications.Chromatography:Thinlayerchromatography(TLC),Gasliquidchromatography(GLC)–Centrifugation:Differentialcentrifugation, density gradient centrifugation. Electrophoresis: Gel electrophoresis,polyacrylamidegel electrophoresis.
UNITVI: PROFESSIONAL COMPONENTS	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and CommunicationSkillEnhancement,SocialAccountabilityandPatriotism

TEXTBOOKS	1. Thecell:Amolecularapproach,GeoffreyM.Cooper,ASMPress,2013. 2. Biophysics,VasanthaPattabhi,N.Gautham,NarosaPublishing,2009 3. Biophysics,P.S.MishraVKEnterprises,2010. 4. Biophysics,M.ASubramanian,MJPPublishers,2005. 5. Bioinstrumentation, L.Veerakumari,MJPPublishers,2006.
REFERENCE BOOKS	1. ChemicalBiophysicsbyDanielABeard(CambridgeUniversityPress,2008). 2. EssentialcellbiologybyBruceAlbertet al(GarlandScience) 3. Biophysics,W.Hoppe,W.Lohmann,H.MarklandH.Ziegler.Springer Verlag,Berlin (1983). 4. Membrane Biophysics byMohammadAshrafuzzaman,JackA.Tuszynski,(Springer science&businessmedia). 5. BiologicalspectroscopybyIain D.Campbell,Raymond A.Dwek
WEBSOURCES	1. GeneralBio:http://www.biology.arizona.edu/DEFAULT.html 2. Spectroscopy:http://www.cis.rit.edu/htbooks/nmr/inside.htm 3. Electrophoresis:http://learn.genetics.utah.edu/content/labs/gel/ 4. Onlinebiophysicsprograms:http://mw.concord.org/modeler/ 5. https://blanco.biomol.uci.edu/WWWResources.html

COURSEOUTCOMES:

Atthe end ofthecourse,the studentwillbeableto:

CO1	Understandthestructuralorganizationandfunctionoflivingcellsandshouldabletoap plythecell signalingmechanism and itselectrical activities.	**K2, K3**
CO2	Comprehensionoftheroleofbiomolecularconformationtofunction.	**K1**
CO3	Conceptualunderstandingofthefunctionofbiologicalmembranesandalsotounderst andthefunctioningof nervous system.	**K2, K5**
CO4	Toknowtheeffectsofvariousradiationsonlivingsystemsandhowtopreventilleffects of radiations.	**K1, K5**
CO5	Analyzeandinterpretdatafromvarioustechniquesviz.,spectroscopy,crystallograph y,chromatographyetc.,	**K4**
K1-Remember;K2–Understand;K3-Apply;K4-Analyze;K5-Evaluate;		

MAPPINGWITHPROGRAMOUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specificoutcomes**(PSO)** inthe 3-pointscaleof STRONG(3), MEDIUM(2)andLOW(1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	3	2	1	2	1	3	3	2
CO2	3	3	3	2	1	2	1	3	3	2
CO3	3	3	3	3	1	1	2	3	3	2
CO4	3	3	3	2	1	1	2	3	3	3
CO5	3	3	3	3	1	1	2	3	3	3

Strong(3)Medium(2)andLow (1)

Elective– 6. CRYSTALGROWTH ANDTHINFILMS		IYEAR-FIRST SEMESTER						
Subject Code	**SubjectName**	**Category**	**L**	**T**	**P**	**Credits**	**Inst.Hours**	**Marks**
23PHYE105	**CRYSTALGROWTHAND THINFILMS**	ELECTIVE	4	1		3	5	75

Pre-Requisites
FundamentalsofCrystalPhysics
LearningObjectives
➢ ToacquiretheknowledgeonNucleationandKineticsofcrystalgrowth ➢ TounderstandtheCrystallizationPrinciplesandGrowthtechniques ➢ TostudyvariousmethodsofCrystalgrowth techniques ➢ Tounderstand thethin filmdeposition methods ➢ Toapplythetechniques ofThin FilmFormationand thicknessMeasurement

UNITS	CourseDetails
UNIT I:CRYSTALGROWTH KINETICS	BasicConcepts,NucleationandKineticsofgrowthAmbientphaseequilibrium - super saturation - equilibrium of finite phases equation ofThomson-Gibbs - Types ofNucleation-Formationofcritical Nucleus - Classical theory of Nucleation - Homo and heterogeneous formation of3D nuclei - rate of Nucleation - Growth from vapourphase solutions,solutionsandmelts-epitaxialgrowth-Growthmechanism andclassification-Kineticsofgrowth ofepitaxialfilms
UNIT II:CRYSTALLIZATIONPRINCIPLES	CrystallizationPrinciplesandGrowthtechniquesClassesofCrystalsystem-Crystalsymmetry -Solventsandsolutions-Solubilitydiagram -Supersolubility-expressionforsupersaturation-Metastablezoneand introduction period - Miers TC diagram – Solutiongrowth - Low andhightemperaturessolutiongrowth-Slowcoolingandsolventevaporationmethods-Constanttemperaturebathasa Crystallizer.
UNIT III:GEL, MELT ANDVAPOURGROWTH	Gel, Melt and Vapour growth techniques Principle of Gel techniques - Various types of Gel - Structure and importance of Gel - Methods of Gelgrowthandadvantages-Melttechniques-Czochralskigrowth-Floating zone - Bridgeman method - Horizontal gradient freeze - Fluxgrowth-Hydrothermalgrowth-Vapourphasegrowth-Physical vapourdeposition-Chemicalvapourdeposition-Stoichiometry.

UNIT IV:THIN FILMDEPOSITIONMETHODS	Thin filmdepositionmethodsofthinfilmpreparation,Thermalevaporation, Electronbeamevaporation,pulsedLASERdeposition,Cathodic sputtering, RF Magnetron sputtering, MBE, chemical vapourdeposition methods, Sol Gel spin coating, Spray pyrolysis, Chemicalbathdeposition.
UNIT V: THIN FILMFORMATION	ThinFilmFormationandthicknessMeasurementNucleation,Filmgrowthandstructure-VariousstagesinThinFilmformation,Thermodynamics of Nucleation, Nucleation theories,Capillaritymodeland Atomistic model and their comparison.Structure of ThinFilm,Roll of substrate, Roll of film thickness, Film thickness measurement - Interferometry,Ellipsometry,Microbalance,Quartz CrystalOscillatortechniques.
UNIT VI:PROFESSIONALCOMPONENTS	ExpertLectures,OnlineSeminars-WebinarsonIndustrialInteractions/Visits,CompetitiveExaminations,EmployableandCommunicationSkillEnhancement,SocialAccountabilityand Patriotism
TEXTBOOKS	1. V. Markov Crystal growth for beginners: Fundamentals ofNucleation,Crystal Growth and Epitaxy(2004)2ndedition 2. A.Goswami,ThinFilmFundamentals(NewAge,NewDelhi,2008) 3. M.OhoraandR. C. Reid, –Modeling of Crystal GrowthRates from Solution‖ 4. 4. D.Elwell and H.J.Scheel, –Crystal Growthfrom High TemperatureSolution‖ 5. HeinzK.Henish,1973, –Crystal Growth in Gels‖,Cambridge UniversityPress. USA
REFERENCE BOOKS	1. J.C.Brice,CrystalGrowth Process(JohnWiley,NewYork,1986) 2. P.RamasamyandF.D.Gnanam, 1983, –UGC Summer School Notes‖. 3. P.SanthanaRaghavanand P.Ramasamy, –Crystal Growth Processes‖, KRUPublications. 4. H.E.Buckley,1951,CrystalGrowth,JohnWileyandSons,NewYork 5. B.R.Pamplin,1980,CrystalGrowth,PergmanPress,London.
WEBSOURCES	1. https://www.youtube.com/playlist?list=PLbMVogVj5nJRjLrXp3kMtrIO8kZl1D1Jp 2. https://www.youtube.com/playlist?list=PLFW6lRTa1g83HGEihgwcy7KeTLUuBu3WF 3. https://www.youtube.com/playlist?list=PLADLRin7kNjG1Dlna9MDA53CMKFHPSi9m 4. https://www.youtube.com/playlist?list=PLXHedI-xbyr8xIl_KQFs_R_oky3Yd1Emw 5. https://www.electrical4u.com/thermal-conductivity-of-metals/

COURSEOUTCOMES:
Atthe end ofthecourse,the studentwillbeableto:

CO1	AcquiretheBasicConcepts,NucleationandKineticsofcrystal growth	**K1**
CO2	UnderstandtheCrystallizationPrinciples andGrowthtechniques	**K2, K4**
CO3	StudyvariousmethodsofCrystalgrowthtechniques	**K3**
CO4	UnderstandtheThinfilmdepositionmethods	**K2**
CO5	ApplythetechniquesofThinFilmFormationandthicknessMeasurement	**K3, K4**
K1-Remember;K2–Understand;K3-Apply;K4-Analyze;K5-Evaluate;		

MAPPINGWITHPROGRAMOUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specificoutcomes**(PSO)** inthe 3-pointscaleof STRONG(3), MEDIUM(2)andLOW(1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	2	1	2	1	3	2	2	2	2
CO2	3	3	1	3	1	2	3	2	2	1
CO3	3	2	1	3	1	2	3	3	3	1
CO4	3	2	1	2	1	2	3	3	3	1
CO5	2	3	3	3	1	3	3	3	3	2

Strong(3)Medium(2)andLow (1)

Elective–7.ADVANCEDOPTICS	IYEAR– SECONDSEMESTER

Subject Code	SubjectName	Category	L	T	P	Credits	Inst.Hours	Marks
23PHYE204	**ADVANCEDOPTICS**	ELECTIVE	4			3	4	75

Pre-Requisites
Knowledgeofrayproperties and wavenatureoflight
LearningObjectives
➢ Toknowtheconceptsbehindpolarizationandcouldpursueresearchworkonapplicationaspectsofl aser ➢ Toimpartanextensiveunderstandingoffiberandnon-linearoptics ➢ Tostudythe workingof different typesofLASERS ➢ Todifferentiatefirstandsecondharmonic generation ➢ Learntheprinciplesofmagneto-opticandelectro-opticeffects anditsapplications

UNITS	CourseDetails
UNIT 1:POLARIZATIONAND DOUBLEREFRACTION	Classificationofpolarization–Transversecharacteroflightwaves–Polarizer and analyzer– Malu‘s law – Production of polarized light – Wiregridpolarizerandthepolaroid–Polarizationbyreflection– Polarizationbydoublerefraction–Polarizationbyscattering– Thephenomenonofdoublerefraction–Normalandobliqueincidence– Interferenceofpolarizedlight:Quarterandhalfwaveplates– Analysisofpolarizedlight–Opticalactivity
UNIT II:LASERS	Basic principles – Spontaneousand stimulated emissions – Componentsofthelaser–Resonatorandlasingaction– Typesoflasersanditsapplications–Solidstatelasers–Rubylaser– Nd:YAGlaser–gaslasers– He-Ne laser – CO_2 laser – Chemical lasers – HCl laser – Semiconductorlaser
UNIT III:FIBEROPTICS	Introduction – Total internal reflection – The optical fiber – Glass fibers – The coherent bundle – The numerical aperture – Attenuation in opticalfibers – Single and multi-mode fibers – Pulse dispersion in multimodeoptical fibers – Ray dispersion in multimode step index fibers – Parabolic-indexfibers–Fiber-opticsensors:precisiondisplacementsensor– Precisionvibrationsensor
UNIT IV:NON-LINEAROPTICS	Basic principles – Harmonic generation – Second harmonic generation – Phasematching–Thirdharmonicgeneration–Opticalmixing– Parametricgeneration oflight –Self-focusingof light
UNIT V:MAGNETO-OPTICS ANDELECTRO-	Magneto-opticaleffects–Zeemaneffect–InverseZeemaneffect–Faraday effect – Voigt effect – Cotton-mouton effect – Kerr magneto-optic effect – Electro-optical effects – Stark effect – Inverse stark effect – Electricdoublerefraction–Kerrelectro-opticeffect–Pockelselectro-opticeffect

OPTICS	
UNITVI: PROFESSIONAL COMPONENTS	ExpertLectures,OnlineSeminars-WebinarsonIndustrialInteractions/Visits,CompetitiveExaminations,EmployableandCommunicationSkillEnhancement,SocialAccountabilityandPatriotism
TEXTBOOKS	1. B.B.Laud,2017,LasersandNon–LinearOptics,3rdEdition,NewAgeInternational (P)Ltd. 2. AjoyGhatak,2017,Optics,6thEdition,McGraw–HillEducationPvt.Ltd. 3. William T. Silfvast, 1996, Laser Fundamentals Cambridge UniversityPress,NewYork 4. J.Peatros,PhysicsofLightandOptics,agood(andfree!)electronicbook 5. B. Saleh, and M. Teich, Fundamentals of Photonics,Wiley-Interscience,
REFERENCE BOOKS	1. F.S.JenkinsandH.E.White,1981,FundamentalsofOptics,(4thEdition),Mc Graw– HillInternationalEdition. 2. DieterMeschede,2004,Optics,LightandLasers,Wiley–VCH,VarleyGmbH. 3. Lipson, S. G. Lipson and H. Lipson, 2011, Optical Physics, 4th Edition,CambridgeUniversityPress, NewDelhi, 2011. 4. Y.B. Band, Light and Matter,WileyandSons (2006) 5. R.Guenther,ModernOptics,WileyandSons(1990)
WEBSOURCES	1. https://www.youtube.com/watch?v=WgzynezPiyc 2. https://www.youtube.com/watch?v=ShQWwobpW60 3. https://www.ukessays.com/essays/physics/fiber–optics–and–it-applications.php 4. https://www.youtube.com/watch?v=0kEvr4DKGRI 5. http://optics.byu.edu/textbook.aspx

COURSEOUTCOMES:
Atthe end ofthecourse,the studentwillbeableto:

CO1	Discussthetransversecharacteroflightwavesanddifferentpolarizationphenomenon	**K1**
CO2	Discriminateallthefundamentalprocessesinvolvedinlaserdevicesandtoanalyzethe design and operation ofthedevices	**K2**
CO3	Demonstratethebasicconfigurationofafiberoptic–communicationsystemandadvantages	**K3, K4**
CO4	Identifythepropertiesofnonlinearinteractionsoflightandmatter	**K4**
CO5	Interpretthegroupofexperimentswhichdependfortheiractiononanappliedmagneticsand electricfield	**K5**
K1-Remember;K2–Understand;K3-Apply;K4-Analyze;K5-Evaluate;		

MAPPINGWITHPROGRAMOUTCOMES:
Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specificoutcomes**(PSO)** inthe 3-pointscaleof STRONG(3), MEDIUM(2)andLOW(1)**.**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	3	3	3	3	3	3
C02	3	3	3	2	3	3	3	3	3	3
CO3	3	3	3	2	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3

Strong(3)Medium(2)andLow (1)

Elective– **8.ADVANCEDMATHEMATICALPHYSICS**	**I YEAR–SECONDSEMESTER**

Subject Code	**SubjectName**	**Category**	**L**	**T**	**P**	**Credits**	**Inst.Hours**	**Marks**
23PHYE204	**ADVANCED MATHEMATICALPHYSICS**	ELECTIVE	4			3	4	75

Pre-Requisites
Goodknowledgeinbasicmathematics
LearningObjectives
➢ Toeducateandinvolvestudentsinthehigherlevelofmathematicsandmathematicalmethodsrelevant and applicable to Physics.

UNITS	**CourseDetails**
UNIT I:DISCRETEGROUPS	Definition of a group, subgroup, class, Lagrange‘s theorem, invariant subgroup,Homomorphism and isomorphismbetweentwogroups.Representation of agroup, unitary representations, reducible and irreducible representations Schur‘slemmas,orthogonalitytheorem,charactertable,reductionofKronecker productofrepresentations,criterionforirreducibilityof arepresentation.
UNIT II:CONTINUOUSGROUPS	Infinitesimal generators, Lie algebra; Rotation group, representations of the Liealgebra of the rotation group, representation of the rotation group, D-matricesandtheirbasicproperties.AdditionoftwoangularmomentaandC.G.coefficients,Wigner-Eckarttheorem.
UNITIII: SPECIAL UNITARY GROUPS	Definition of unitary, unimodular groups SU (2) and SU(3). Lie algebra ofSU(2).RelationbetweenSU(2)androtationgroup.LiealgebraofSU(3)-Gellmann‘s matrices. Cartan form of the SU(3). Lie algebra, roots and rootdiagramforSU(3).Weightsandtheirproperties,weightdiagramsfortheirreducible representations 3.3*-, 6,6 8, 10 and 10 of SU(3).Direct product oftwoSU(3)representations,Youngtableauxmethodofdecompositionofproductsof IR‘sillustrationswiththerepresentationsofdim<10.C.G.coefficientsfor3x3*and3x6representations.SU(3)symmetryinelementaryparticlephysics,quantumnumbersofhadronsandSU(2)andSU(3)classificationofhadrons.

UNIT IV:TENSORS	Cartesian vectors and tensors illustration with moment of inertia, conductivity,dielectric tensors. Four vector in special relativity, vectors andtensors underLorentz transformations, Illustration from physics. Vectors andtensors undergeneral co-ordinate transformations, contravariantand covariant vectors andtensors,mixedtensors;tensor algebra,addition,subtraction, direct productoftensors,quotienttheorem,symmetricand antisymmetric tensors.
UNIT V:TENSOR CALCULUS	Parallel transport,covariantderivative,affineconnection. Metric tensor.ExpressionforChristoffelsymbolsintermsofand itsderivatives(assumingDg= 0. Curvature tensor, Ricci tensor and Einstein tensor.Bianchi identities,Schwarzschildsolution to theEinstein equation G=0.
UNITVI: PROFESSIONAL COMPONENTS	ExpertLectures,OnlineSeminars-WebinarsonIndustrialInteractions/Visits, CompetitiveExaminations,EmployableandCommunicationSkillEnhancement,SocialAccountabilityand Patriotism
TEXTBOOKS	1. A.W.Joshi,Group TheoryforPhysicists 2. D.B.Lichtenberg,UnitarySymmetryandElementaryParticles 3. E.Butkov,MathematicalPhysics 4. J.V. Narlikar, GeneralRelativity&Cosmology 5. R.Geroch,MathematicalPhysics,TheUniversityofChicagopress(1985).
REFERENCE BOOKS	***1.*** M.Hamermesh***GroupTheory*** ***2.*** M. E. Rose: ElementaryTheoryofAngularMomentum ***3.*** Georgi:LieGroupsforPhysicists ***4.*** E. A.Lord:Tensors, Relativity&Cosmology ***5.*** P.Szekeres,Acourseinmodernmathematicalphysics:Groups,Hilbertspaces anddifferentialgeometry,Cambridge UniversityPress.
WEBSOURCES	1. https://vdoc.pub/documents/unitary-symmetry-and-elementary-particles-c4qsfejthkc0 2. https://physics.iith.ac.in/HEP_Physics/slides/poplawskitalk.pdf 3. https://www.hindawi.com/journals/amp/ 4. https://projecteuclid.org/journals/advances-in-theoretical-and-mathematical-physics 5. https://www.springer.com/journal/11232

COURSEOUTCOMES:

Atthe endof thecourse,thestudentwill beableto:

CO1	Gainedknowledgeofboth discreteand continuousgroups	**K1**
CO2	Applyvariousimportanttheoremsingrouptheory	**K3**
CO3	Constructgroupmultiplicationtable,charactertablerelevanttoimportantbranches ofphysics.	**K5**
CO4	Equippedto solveproblemsintensors	**K4,K5**
CO5	Developedskillsto applygrouptheoryand tensorsto peruseresearch	**K2,K3**
K1-Remember;K2–Understand;K3-Apply;K4-Analyze;K5-Evaluate;		

MAPPINGWITHPROGRAMOUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specificoutcomes**(PSO)** inthe 3-point scaleofSTRONG(3), MEDIUM(2)andLOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	2	1	1	2	1	2	3	3

CO2	3	3	2	1	1	1	1	2	3	2
CO3	3	3	2	1	2	2	1	2	3	2
CO4	3	3	2	2	1	2	1	2	3	2
CO5	3	3	2	2	2	1	1	2	3	2

Strong(3)Medium(2)andLow (1)

Elective–9.PLASMAPHYSICS	IYEAR–SECONDSEMESTER

Subject Code	SubjectName	Category	L	T	P	Credits	Inst.Hours	Marks
23PHYE204	**PLASMAPHYSICS**	ELECTIVE	4			3	4	75

Pre-Requisites
FundamentalsofElectricityandMagnetism,Electromagnetictheory, Maxwell'sequation,Basicknowledgeofelectrical and electronicsinstrumentation.
LearningObjectives
➢ Toexploretheplasmauniversebymeansofin-siteandground-basedobservations. ➢ Tounderstandthemodelplasmaphenomenaintheuniverse. ➢ Toexplorethephysicalprocesseswhichoccurinthespaceenvironment.

UNITS	CourseDetails
UNIT I:FUNDAMENTALCONCEPTS OFPLASMA	Kinetic pressure in a partially ionized - mean free path and collisioncross section - Mobility of charged particles - Effect of magnetic fieldon the mobility of ions and electrons-Thermal conductivity- Effect ofmagneticfield-Quasi-neutralityofplasmaDebyeshieldingdistance –Opticalpropertiesofplasma.
UNIT II:MOTION OFCHARGED PARTICLESIN ELECTRIC ANDMAGNETICFIELD	Particledescriptionof plasma- Motionof chargedparticle inelectrostatic-field-Motionofchargedparticleinuniformmagneticfield-Motionof charged particle in electric and magnetic fields-Motion of charged particle inhomogeneousmagneticfield-Motionofchargedparticleinmagnetic mirror confinement - motion of anelectron in a time varying electric field- Magneto- hydrodynamics - Magnetohydrodynamicequations–Condition formagnetohydrodynamicbehaviour.
UNIT III: PLASMAOSCILLATIONSANDWAVES	Introduction, theory of simple oscillations - electron oscillation inaplasma–DerivationsofplasmaoscillationsbyusingMaxwell'sequation - Ion oscillation and waves in a magnetic field-thermaleffectsonplasmaoscillations-Landaudamping-Hydromagnetic waves-Oscillationsinanelectronbeam.
UNIT IV:PLASMADIAGNOSTICSTECHNIQUES	Singleprobemethod-Doubleprobemethod-Useofprobetechniqueformeasurementofplasmaparametersinmagneticfield-microwavemethod -spectroscopicmethod--laserasatoolfor plasmadiagnostics-X-raydiagnostics of plasma-acousticmethod-conclusion.
UNIT V:APPLICATIONSOFPLASMAPHYSICS	MagnetohydrodynamicGenerator-Basictheory-PrincipleofWorking-FuelinMHDGenerator-GenerationofMicrowavesUtilizingHighDensityPlasma-PlasmaDiode.
UNIT VI:PROFESSIONALCOMPONEN	Expert Lectures, Online Seminars – Webinars on IndustrialInteractions/Visits, Competitive Examinations, EmployableandCommunicationSkillEnhance

TS	ment,SocialAccountabilityandPatriotism

TEXTBOOKS	1. PlasmaPhysics-PlasmaStateof Matter - S. N. Sen, PragatiPrakashan,Meerut. 2. IntroductiontoPlasmaPhysics-M.Uman 3. Krall, N. A., and A. W. Trivelpiece. Principles of Plasma Physics. Berkeley,CA:San FranciscoPress,1986. ISBN:9780911302585.Tanenbaum, B. S.PlasmaPhysics.NewYork,NY:McGraw-Hill,1967.ISBN:9780070628120. 4. Goldston,R.J.,andP.H.Rutherford.IntroductiontoPlasmaPhysics.Philadelphia, PA:IOPPublishing,1995. ISBN:9780750301831. 5. Hutchinson, I. H. Principles of Plasma Diagnostics. Cambridge, UK:CambridgeUniversityPress,2005. ISBN:9780521675741.
REFERENCE BOOKS	1. Chen,F.F.IntroductiontoPlasmaPhysics.2nded.NewYork,NY:Springer, 1984.ISBN:9780306413322. 2. IntroductiontoPlasmaTheory-D.R. Nicholson 3. Shohet,J.L.ThePlasmaState.SanDiego,CA:AcademicPressInc.,1971.ISBN:9 780126405507. 4. Hazeltine,R.D.,andF.L.Waelbroeck.TheFrameworkofPlasmaPhysics.B oulder,CO:WestviewPress,2004. ISBN:9780813342139. 5. Huddlestone, R.H.andS.L.Leonard.PlasmaDiagnosticTechniques.SanDiego, CA: AcademicPress, 1965
WEBSOURCES	1. https://fusedweb.llnl.gov/Glossary/glossary.html 2. http://farside.ph.utexas.edu/teaching/plasma/lectures1/index.html 3. http://www.plasmas.org/ 4. http://www.phy6.org/Education/whplasma.html 5. http://www.plasmas.org/resources.htm

COURSEOUTCOMES:

Atthe end ofthecourse,the studentwillbeableto:

CO1	Understandthecollision,crosssectionofchargedparticlesandtoabletocorrelatethemag neticeffect of ion andelectrons in plasmastate.	**K1,K2**
CO2	Understandtheplasmaandlearnthemagneto-hydrodynamicsconceptsappliedto plasma.	**K2**
CO3	ExploretheoscillationsandwavesofchargedparticlesandtherebyapplytheˆMaxwell‘s equation to quantitativeanalysis of plasma.	**K1,K3**
CO4	Analyzethedifferentprincipleandtechniquestodiagnosticsofplasma.	**K2,K5**
CO5	Learnthepossibleapplicationsofplasmabyincorporatingvariouselectricalandelectro nicinstruments.	**K4**
K1-Remember;K2–Understand;K3-Apply;K4-Analyze;K5-Evaluate;		

MAPPINGWITHPROGRAMOUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specificoutcomes**(PSO)** inthe 3-pointscaleof STRONG(3), MEDIUM(2)andLOW(1)**.**

	PO 1	**PO2**	**PO 3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO 8**	**PO9**	**PO1 0**
CO1	3	3	2	1	1	2	1	2	3	3
CO2	3	3	2	1	1	2	1	2	3	3

CO3	3	3	2	2	1	2	1	3	3	3
CO4	3	3	3	2	1	2	1	3	3	3
CO5	3	3	3	2	1	2	1	3	3	3

Strong(3)Medium(2)andLow (1)

Elective– 10. MICROPROCESSOR 8085 AND MICROCONTROLLER8051	IYEAR– SECONDSEMESTER

SubjectCode	SubjectName	Category	L	T	P	Credits	Inst.Hours	Marks
23PHYE205	**MICROPROCESSOR8085AND MICROCONTROLLER8051**	ELECTIVE	4			3	4	75

Pre-Requisites
Knowledgeof number systems and binaryoperations

LearningObjectives
➢ Toprovideanunderstandingofthearchitectureandfunctioningofmicroprocessor8085Aand tothemethodsofinterfacingI/Odevices andmemoryto microprocessor ➢ Tointroduce8085Aprogrammingandapplicationsandthearchitectureandinstructionsetsof microcontroller 8051

UNITS	CourseDetails
UNIT I: 8085PROGRAMMING,PERIPHERALDEVICES ANDTHEIR INTERFACING	Instructionset-Addressingmodes-Programmingtechniques-Memorymapped I/O scheme- I/O mapped I/O scheme - Memory and I/O interfacing-Data transfer schemes - Interrupts of 8085 - Programmable peripheral interface(PPI)-Controlgroupandcontrolword-ProgrammableDMAcontroller-Programmable interrupt controller – Programmable communication interface -Programmable counter/interval timer.
UNIT II:8085 INTERFACING APPLICATIONS	Sevensegmentdisplayinterface-InterfacingofDigitaltoAnalogconverterandAnalogtoDigitalconverter-Steppermotorinterface-Measurementofelectricalquantities–Voltageandcurrent)Measurementofphysicalquantities(Temperatureanstrain).
UNIT III:8051 MICRO CONTROLLER HARDWARE	Introduction – Features of 8051 – 8051 Microcontroller Hardware: Pin-out8051, Central Processing Unit (CPU), internal RAM, Internal ROM, Registerset of 8051 – Memory organization of 8051 – Input/ Output pins, Ports andCircuits–Externaldatamemory andprogrammemory:Externalprogrammemory,External datamemory.
UNIT IV: 8051INSTRUCTIONSET ANDASSEMBLY LANGUAGEPROGRAMMING	Addressing modes – Data moving (Data transfer) instructions: Instructions toAccess external data memory, external ROM / program memory, PUSH andPOPinstructions, Data exchange instructions – Logical instructions:byte andbitlevellogicaloperations,Rotateandswapoperations–Arithmeticinstructions:Flags,Incrementinganddecrementing,Addition,Subtraction,Multiplicationanddivision,Decimalarithmetic–JumpandCALLinstructions:JumpandCallprogramrange,Jump,Callandsubroutines–Programming.

UNIT V:INTERRUPTPROGRAMMINGANDINTERFACINGTOEXTERNALWORLD	8051 Interrupts – Interrupt vector table – Enabling and disabling an interrupt –Timerinterruptsandprogramming– Programmingexternalhardwareinterrupts– Serial communication interrupts and programming – Interrupt priority in the8051:Nestedinterrupts,Softwaretriggeringofinterrupt.LEDInterfaceSeven segment display interface- Interfacing ofDigital to Analog converterand Analog to Digital converter –Steppermotor interface - Measurement ofelectrical quantities – Voltage and current) Measurement ofphysicalquantities(Temperatureanstrain).
UNITVI: PROFESSIONALCOMPONENTS	ExpertLectures,OnlineSeminars-WebinarsonIndustrialInteractions/Visits,Competitive Examinations, Employable and Communication SkillEnhancement,Social Accountabilityand Patriotism
TEXTBOOKS	1. A. NagoorKani,Microprocessors&Microcontrollers,RBAPublications(2009). 2. A.P.GodseandD.A.Godse,Microprocessors,TechnicalPublications,Pune(2009). 3. RameshGaonkar,Microprocessor Architecture,ProgrammingandApplicationswith8085,PenramInternationalPublishing(2013). 4. B. Ram, Fundamentals of Microprocessors &Microcontrollers,DhanpatRaipublicationsNew Delhi (2016). 5. V.Vijayendran,2005,FundamentalsofMicroprocessor-8085‖,3rd EditionS.VisvanathanPvt,Ltd.
REFERENCE BOOKS	1. DouglasV.Hall,MicroprocessorsandInterfacingprogrammingandHardware,TataMcGraw Hill Publications (2008) 2. Muhammad Ali Mazidi, Janice GillispieMazidi, Rolin D.Mckinlay, The8051Microcontroller andEmbeddedSystems,PearsonEducation(2008). 3. BarryB.Brey,1995,TheIntelMicroprocessors8086/8088,80186,80286,80386and80486, 3rdEdition,Prentice-Hallof India, NewDelhi. 4. J.Uffrenbeck, The8086/8088 Family-Design, Programming and Interfacing, Software, Hardware and Applications‖, Prentice-Hall ofIndia,NewDelhi. 5. W.A.Tribel,AvtarSingh, The 8086/8088 Microprocessors: Programming,Interfacing,Software,HardwareandApplications‖, 6. Prentice-HallofIndia,NewDelhi.
WEBSOURCES	1. https://www.tutorialspoint.com/microprocessor/microprocessor_8085_architecture.html 2. http://www.electronicsengineering.nbcafe.in/peripheral-mapped-io-interfacing/ 3. https://www.geeksforgeeks.org/programmable-peripheral-interface-8255/ 4. http://www.circuitstoday.com/8051-microcontroller 5. https://www.elprocus.com/8051-assembly-language-programming/

COURSE OUTCOMES:

Atthe end ofthecourse,the studentwillbeableto:

CO1	Gainknowledgeofarchitectureandworkingof8085microprocessor.	**K1**
CO2	Getknowledgeofarchitectureandworkingof8051 Microcontroller.	**K1**
CO3	Be able to write simple assembly language programs for 8085Amicroprocessor.	**K2, K3**
CO4	Abletowritesimpleassemblylanguageprogramsfor8051Microcontroller.	**K3, K4**
CO5	Understandthedifferentapplicationsofmicroprocessorandmicrocontroller.	**K3, K5**
K1-Remember;K2–Understand;K3-Apply;K4-Analyze;K5-Evaluate;		

MAPPINGWITHPROGRAMOUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specificoutcomes**(PSO)** inthe 3-point scale ofSTRONG(3),MEDIUM(2)**and**LOW(1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	2	3	3	3	3	1	1	1	1	1
CO2	2	1	1	1	1	1	1	1	1	1
CO3	3	3	3	3	3	1	1	1	1	1
CO4	3	3	3	3	3	1	1	1	1	1
CO5	3	3	3	3	3	1	1	1	1	1

Strong(3)Medium(2)andLow (1)

Elective–11.ADVANCEDSPECTROSCOPY	I YEAR–SECONDSEMESTER

SubjectCode	SubjectName	Category	L	T	P	Credits	Inst.Hours	Marks
23PHYE205	**ADVANCEDSPECTROSCOPY**	ELECTIVE	4			3	4	75

Pre-Requisites
Basicknowledgeof grouptheory,abstractthinkingability,lasers, chemicalbondsandmolecularstructures

LearningObjectives
➢ Helpsstudentsunderstandandappreciatespectroscopyasasufficientlybroadfieldinwhichmanysubdisciplines exist. ➢ Makethemappreciateeach ofthesespecifictechniqueswith numerousimplementations. ➢ Torealizetheprogressinthisfieldthatisrapid,resultinginimprovedinstrumentcapabilitiesand aneverwideningrangeof applications. ➢ Toapplygrouptheoryinspectroscopytoshedlightonmolecularsymmetryanddetermineimportantphysicalparameters.

UNITS	CourseDetails
UNIT I:MOLECULARSPECTROSCOPY AND GROUPTHEORY	Group axioms –subgroup, simple group, Abelian group, cyclicgroup, order of agroup, class- Lagrange's theorem statement and proof - Symmetry operations andsymmetry elements - Application: constructionof group multiplication table (notcharacter table) for groups of order 2, 3, cyclic group of order 4, noncyclic groupof order 4 – reducible and irreducible representations- Unitary representations –Schur'slemmas–Greatorthogonalitytheorem-pointgroup-Simpleapplications:Symmetryoperationsofwaterandammonia-ConstructionofcharactertableforC$_{2v}$(water)andC$_{3v}$(ammonia)molecules
UNIT II:LASERSPECTROSCOPY	Lasers as Spectroscopy Light sources – Special Characteristics of Laser emission-ultra short pulses- laser cooling -Single and multi-mode lasers- Laser tenability-Fluorescence spectroscopy with lasers- Laser Raman Spectroscopy – Non-linearSpectroscopy– ApplicationsofLaserSpectroscopyinmedicalfields,materialsscienceresearch
UNITIII: MOSSBAUERSPECTROSCOPY	Basic idea of Mossbauer spectroscopy - Principle- Mossbauer effect-Recoillessemission and absorption- Chemical shift -Effect of electric and magnetic fields –hyperfineinteractions-instrumentation-Applications:understandingmolecularandelectronicstructures
UNIT IV:XRAYPHOTOELECTRONSPECTROSCOPY	Principle–XPSspectraanditsinterpretation-ECSA-EDAX-otherformsofXPS–chemicalshift-Applications:-stoichiometricanalysis-electronicstructure-XPEStechniquesusedinastronomy,glassindustries,paintsandinbiologicalresearch

UNIT V:MOLECULARMODELLING	Determination of force constants- force fieldfrom spectroscopic data-normalcoordinateanalysisofasimplemolecule(H_2O)– analyzingthermodynamicfunctions, partition functions, enthalpy, specific heat and relatedparametersfromspectroscopicdata-molecularmodellingusingdatafromvariousspectroscopic studies
UNIT VI:PROFESSIONAL COMPONENTS	ExpertLectures,OnlineSeminars-WebinarsonIndustrialInteractions/Visits,CompetitiveExaminations,EmployableandCommunicationSkillEnhancement, SocialAccountabilityandPatriotism

TEXTBOOKS	1. WilliamKemp,2019,OrganicSpectroscopy(2nd Edition)MacMillan,IndianEdition. 2. CNBanwellandMcCash,1994,FundamentalsofMolecularSpectroscopy,4thEdition,Tata McGraw–Hill,NewDelhi. 3. D.N. Satyanarayana, 2001, *Vibrational Spectroscopy andApplications*,NewAgeInternationalPublication. 4. B.K.Sharma,2015,*Spectroscopy*, GoelPublishingHouseMeerut. 5. JM Hollas, 2002, BasicAtomic and MolecularSpectroscopy, RoyalSocietyof Chemistry, RSC, Cambridge.
REFERENCE BOOKS	1. Demtroder. W, Laser Spectroscopy: Basic concepts andInstrumentation, SpringerLink. 2. B.P.StraughanandS.Walker,1976,SpectroscopyVol.I.,ChapmanandHall,NewYork. 3. JLMcHale,2008,MolecularSpectroscopy,PearsonEducationIndia,NewDelhi. 4. David.L.Andrews,Introductionto LaserSpectroscopy,Springer,2020 5. Kalsi.P.S,2016,SpectroscopyofOrganicCompounds(7th Edition)NewAgeInternational Publishers.
WEBSOURCES	1. FundamentalsofSpectroscopy-Course(nptel.ac.in) 2. http://mpbou.edu.in/slm/mscche1p4.pdf 3. https://onlinecourses.nptel.ac.in/noc20_cy08/preview 4. https://www.coursera.org/lecture/spectroscopy/nmr-spectroscopy-introduction-XCWRu 5. https://serc.carleton.edu/research_education/geochemsheets/techniques/mossbauer.html

COURSEOUTCOMES:

Atthe end ofthecourse,the studentwillbeableto:

CO1	Comprehendsetofoperationsassociatedwithsymmetryelementsofamolecule,apply mathematical theory while working with symmetry operations. Applymathematical theory while working with symmetry operations. To use grouptheoryasatooltocharacterizemolecules.	**K1,K2**
CO2	Alignwiththerecentadvancesinsemiconductorlasertechnologycombined sensitivespectroscopicdetectiontechniques.	**K3**

CO3	Understand principlebehindMossbauerspectroscopyandapplytheconceptsof isomershiftandquadrupolesplittingtoanalysemolecules.	**K2,K3**
CO4	AssimilatethisXPESquantitativetechniqueandtheinstrumentationassociated withthis,asappliedinunderstandingsurfaceofmaterials.	**K3, K4**
CO5	EmployIRandRamanspectroscopicdata along with otherdataforstructuralinvestigation of molecules. Analyze thermodynamic functions and otherparameterstoevolve molecularmodels.	**K5**
K1-Remember;K2–Understand;K3-Apply;K4-Analyze;K5-Evaluate;		

MAPPINGWITHPROGRAMOUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specificoutcomes**(PSO)** inthe 3-pointscaleof STRONG(3), MEDIUM(2)andLOW(1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	2	2	3	3	3	3	3	2
CO2	2	2	2	3	3	3	2	3	3	2
CO3	2	2	3	3	3	3	3	2	3	3
CO4	3	2	3	3	2	3	3	3	3	2
CO5	3	2	3	3	3	3	3	3	3	3

Strong(3)Medium(2)andLow (1)

Elective–12.MEDICAL PHYSICS	**IYEAR– SECONDSEMESTER**

Subject Code	**SubjectName**	**Category**	**L**	**T**	**P**	**Credits**	**Inst. Hours**	**Marks**
23PHYE205	**MEDICALPHYSICS**	ELECTIVE	4			3	4	75

Pre-Requisites
Fundamentalsofphysiologicalconcepts,Basicsofinstrumentsprinciple,
LearningObjectives
➢ TounderstandthemajorapplicationsofPhysics toMedicine ➢ Tostudythe aidof different medicaldevices suchasX-raymachines,gammacamera,acceleratorand nuclearmagneticresonance. ➢ TooutlinetheprinciplesofPhysicsofdifferentmedicalradiationdevicesandtheirmodernadvances, especially in medical radiation therapy and different applications in medicalphysics. ➢ TointroducetheideasofRadiography. ➢ Toformagoodbaseforfurtherstudieslikeresearch.

UNITS	CourseDetails
UNITI: X-RAYS ANDTRANSDUCERS	ElectromagneticSpectrum–ProductionofX-Rays–X-RaySpectrum–Bremsstrahlung–CharacteristicX-Ray–X-RayTubes–CoolidgeTube–X-Ray Tube Design –Thermistors – photoelectrictransducers –Photovoltaiccells – photoemissivecells–Photoconductivecells– piezoelectrictransducer
UNIT II: BLOODPRESSURE MEASUREMENTS	Introduction–sphygmomanometer –Measurementofheartrate–basicprinciplesofelectrocardiogram(ECG)–Basicprinciplesofelectro-neurography(ENG)–Basicprinciplesofmagneticresonanceimaging(MRI).
UNIT III:RADIATION PHYSICS	Radiation Units – Exposure – Absorbed Dose – Rad to Gray – Kera RelativeBiologicalEffectiveness–Effective Dose–Sievert(Sv) – InverseSquareLaw–InteractionofradiationwithMatter–LinearAttenuationCoefficient–RadiationDetectors–ThimbleChamber–CondenserChambers–GeigerCounter– Scintillation Counter
UNIT IV:MEDICAL IMAGINGPHYSICS	RadiologicalImaging – Radiography – Filters – Grids – Cassette – X-RayFilm – Film processing – Fluoroscopy – Computed Tomography Scanner –PrincipalFunction–Display–Mammography–UltrasoundImaging–Magnetic Resonance Imaging – Thyroid Uptake System – Gamma Camera(OnlyPrinciple,Function and display)
UNIT V:RADIATION PROTECTION	PrinciplesofRadiationProtection–ProtectiveMaterials –RadiationEffects – Somatic – Genetic Stochastic and Deterministic Effect – Personal MonitoringDevices–TLDFilmBadge– Pocket Dosimeter
UNITVI: PROFESSIONAL COMPONENTS	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits,CompetitiveExaminations,EmployableandCommunicationSkillEnhancement,Social Accountabilityand Patriotism

TEXTBOOKS	1. Dr.K.Thayalan,*BasicRadiologicalPhysics*,JayapeeBrothersMedicalPublishingPvt. Ltd. NewDelhi, 2003. *2.* Curry, Dowdeyand Murry,*Christensen'sPhysicsofDiagnosticRadiology:-Lippincot*WilliamsandWilkins,1990. 3. FMKhan,*PhysicsofRadiationTherapy*,WilliamandWilkins,3rded,2003. 4. D.J.Dewhurst,*AnIntroductiontoBiomedicalInstrumentation*,1sted,Elsevier Science,2014. 5. R.S.Khandpur, *HandBookofBiomedical Instrumentations*, 1sted, TMG, NewDelhi,2005.

REFERENCE BOOKS	1. MuhammadMaqbool,*AnIntroductiontoMedicalPhysics*,1sted,SpringerInternationalPublishing,2017. 2. DanielJirák,FrantišekVítek,*BasicsofMedicalPhysics*,1sted,CharlesUniversity,Karolinum Press,2018 3. AndersBrahme,*ComprehensiveBiomedicalPhysics*,Volume1,1sted,ElsevierScience,2014. 4. K.VenkataRam,*Bio-MedicalElectronicsandInstrumentation*,1sted,GalgotiaPublications,NewDelhi, 2001. 5. JohnR.CameronandJamesG.Skofronick,2009,MedicalPhysics,JohnWileyInterscience Publication,Canada, 2ndedition.
WEBSOURCES	1.https:nptel.ac.in/courses/108/103/108103157/ 2. https://www.studocu.com/en/course/university-of-technology-sydney/medical-devices-and-diagnostics/225692 3. https://www.technicalsymposium.com/alllecturenotes_biomed.html 4. https://lecturenotes.in/notes/17929-note-for-biomedical-instrumentation-bi-by-deepraj-adhikary/78 5. https://www.modulight.com/applications-medical/

COURSEOUTCOMES:
Atthe end ofthecourse,the studentwillbeableto:

CO1	Learnthefundamentals,productionandapplicationsofX-rays.	**K1**
CO2	Understandthebasicsof bloodpressuremeasurements.Learnabout sphygmomanometer,EGC,ENGandbasicprinciplesofMRI.	**K2**
CO3	ApplyknowledgeonRadiationPhysics	**K3**
CO4	AnalyzeRadiologicalimagingandfilters	**K4**
CO5	Assesstheprinciples ofradiationprotection	**K5**
K1-Remember;K2–Understand;K3-Apply;K4-Analyze;K5-Evaluate;		

MAPPINGWITHPROGRAMOUTCOMES:
Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specificoutcomes**(PSO)** inthe 3-point scaleofSTRONG(3),MEDIUM(2)**and**LOW(1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	3	1	1	2	3	3	1	3
CO2	3	3	3	2	1	2	3	3	1	3
CO3	3	3	3	2	1	2	3	3	1	3
CO4	3	3	3	2	1	2	3	3	1	3
CO5	3	3	3	1	1	2	3	3	1	3

Strong(3)Medium(2)andLow (1)

Elective– 13. PHYSICSOFNANOSCIENCEANDTECHNOLOGY	**IIYEAR–THIRD SEMESTER**

SubjectCode	SubjectName	Category	L	T	P	Credits	Inst.Hours	Marks
23PHYE305	**PHYSICSOF NANOSCIENCE ANDTECHNOLOGY**	ELECTIVE	3			3	3	75

Pre-Requisites
BasicknowledgeinSolidStatePhysics
LearningObjectives
➢ Physicsof NanoscienceandTechnologyisconcernedwiththe study,creation,manipulationandapplicationsatnanometerscale. ➢ Toprovidethebasicknowledgeaboutnanoscience andtechnology. ➢ Tolearnthestructuresandproperties ofnanomaterials. ➢ Toacquiretheknowledgeaboutsynthesis methodsandcharacterization techniquesanditsapplications.

UNITS	CourseDetails
UNIT I:FUNDAMENTALS OF NANOSCIENCEAND TECHNOLOGY	Fundamentalsofnano–HistoricalPerspectiveonNanomaterialandNanotechnology -–ClassificationofNanomaterials–MetalandSemiconductorNanomaterials-2D,1D, 0D nanostructured materials-Quantumdots–Quantumwires–Quantumwells-Surfaceeffectsofnanomaterials.
UNIT II:PROPERTIESOF NANOMATERIALS	Physical properties of Nanomaterials: Melting points, specific heat capacity, andlattice constant - Mechanical behavior:Elastic properties – strength - ductility -Opticalproperties:-SurfacePlasmonResonance–Quantumsizeeffects-Electricalproperties-Conductivity,Ferroelectricsanddielectrics - Magnetic properties – super para magnetism – Diluted magneticsemiconductor(DMS).
UNIT III:SYNTHESIS ANDFABRICATI ON	Physicalvapourdeposition-Chemicalvapourdeposition-sol-gel–Wetdeposition techniques - electrochemical deposition method – Plasmaarching-Electrospinningmethod-ballmillingtechnique-pulsedlaser deposition-Nanolithography:photolithography.
UNIT IV:CHARACTERIZATI ONTECHNIQUES	Powder X-ray diffraction – X-ray photoelectron spectroscopy (XPS) - UV-visiblespectroscopy–Photoluminescence-Scanningelectronmicroscopy(SEM)-Transmissionelectronmicroscopy(TEM)-Scanning probe microscopy (SPM)-VibratingsampleMagnetometer.
UNITV:APPLICATIONS OFNANOMATERIALS	Sensors: Nanosensors based on optical and physical properties - Electrochemicalsensors – Nano-biosensors. Nano Electronics: Nanobots - display screens - Photocatalytic application: Airpurification,waterpurification-Medicine:Imagingofcancercells–biologicaltags - drug delivery - Energy: fuel cells - rechargeablebatteries -supercapacitors-photovoltaics.

UNIT VI:PROFESSIONALCOMPONENTS	ExpertLectures,OnlineSeminars-WebinarsonIndustrialInteractions/Visits,Competitive Examinations, Employable and Communication Skill Enhancement,SocialAccountabilityandPatriotism
TEXTBOOKS	1. AtextbookofNanoscienceandNanotechnology,PradeepT.,TataMcGraw-HillPublishingCo. (2012). 2. PrinciplesofNanoscienceandNanotechnology,M.A.Shah,TokeerAhmad,NarosaPublishingHousePvtLtd.,(2010). 3. IntroductiontoNanoscienceandNanotechnology,K.K.ChattopadhyayandA.N.Banerjee, PHILearningPvt.Ltd.,NewDelhi, (2012). 4. NanostructuredMaterialsandNanotechnology,HariSinghNalwa,AcademicPress,(2002). 5. NanotechnologyandNanoelectronics,D.P.Kothari,V.VelmuruganandRajitRamSingh,Narosa PublishingHouse Pvt.Ltd,New Delhi.(2018)
REFERENCEBOOKS	1. NanostructuresandNanomaterials –HuozhongGao–Imperial CollegePress(2004). 2. RichardBookerandEarlBoysen,(2005)Nanotechnology,WileyPublishingInc. USA 3. NanoparticlesandNanostructuredfilms;Preparation,CharacterizationandApplications,J. H. FendlerJohn WileyandSons.(2007) 4. TextbookofNanoscienceandNanotechnology,B.S.Murty,etal.,UniversitiesPress.(2012) 5. TheNanoscope(EncyclopediaofNanoscienceandNanotechnology),Dr.Parag DiwanandAshishBharadwaj(2005)Vol.IV-NanoelectronicsPentagonPress,NewDelhi.
WEBSOURCES	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

COURSEOUTCOMES:

Atthe end ofthecourse,the studentwillbeableto:

CO1	Understandthe basicofnanoscienceandexplore the differenttypesofnanomaterialsandshould comprehendthesurfaceeffectsofthenanomaterials.	**K1, K2**
CO2	Explorevariousphysical,mechanical,optical,electricalandmagneticpropertiesnanomaterials.	**K1**
CO3	Understandtheprocessandmechanismofsynthesisandfabricationofnanomaterials.	**K2, K3**
CO4	AnalyzethevariouscharacterizationofNano-productsthroughdiffraction,spectroscopic,microscopic andothertechniques.	**K4**
CO5	Applytheconceptsofnanoscienceandtechnologyinthefieldofsensors,robotics,purification ofair and water andin theenergydevices.	**K3**
K1-Remember;K2–Understand;K3-Apply;K4-Analyze;K5-Evaluate;		

MAPPINGWITHPROGRAMOUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specificoutcomes**(PSO)** inthe 3-pointscaleof STRONG(3), MEDIUM(2)andLOW(1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	3	2	1	1	3	3	3	3

CO2	3	3	3	2	1	1	3	3	3	3
CO3	3	3	2	2	1	1	3	3	3	3
CO4	3	3	3	2	1	1	3	3	3	3
CO5	3	3	2	2	1	1	3	3	3	3

Strong(3)Medium(2)andLow (1)

Elective–14.SOLIDWASTEMANAGEMENT		**IIYEAR– THIRDSEMESTER**						
Subject Code	**SubjectName**	**Category**	**L**	**T**	**P**	**Credits**	**Inst.Hours**	**Marks**
23PHYE305	**SOLID WASTEMANAGEMENT**	ELECTIVE	3			3	3	75

Pre-Requisites
Basicknowledgeofsolidwasteanditstype

LearningObjectives
➢ Togainbasicknowledgein solidwastemanagementprocedures ➢ Togain industryexposureand beequippedto takeup ajob. ➢ Toharnessentrepreneurialskills. ➢ Toanalyzethestatus ofsolidwastemanagement inthenearbyareas. ➢ Tosensitizethe importanceof healthypracticesinwastemanagements

UNITS	**CourseDetails**
UNIT I:SOLID WASTEMANAGEMENT	Introduction - Definition of solid waste - Types – Hazardous Waste: Resourceconservation and Renewal act – Hazardous Waste: Municipal Solid waste andnon-municipalsolidwaste.
UNITII:SOLID WASTE CHARACTERISTICS	SolidWasteCharacteristics:Physicalandchemicalcharacteristics-SWMhierarchy-factorsaffectingSWgeneration

UNITIII: TOOLS ANDEQUIP MENT	Tools and equipment - - Disposal techniques - TransportationCompostingand landfillingtechnique
UNITIV: ECONOMICDEV ELOPMENT	SWM for economic development and environmental protectionLinkingSWM and climatechangeand marine litter.
UNITV: INDUSTRIALVISIT	SWMIndustrialvisit–datacollectionandanalysis-presentation
UNIT VI:PROFESSIO NALCOMPONE NTS	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits,CompetitiveExaminations,EmployableandCommunicationSkillEnhancement,SocialAccountabilityand Patriotism

TEXTBOOKS	1. HandbookofSolidWasteManagement/SecondEdition,GeorgeTchobanoglous, McGrawHill(2002). 2. ProspectsandPerspectivesofSolidWasteManagement,Prof.BBHosett,New AgeInternational (P)Ltd(2006). 3. SolidandHazardousWasteManagement,SecondEdition,M.NRao,BSP /BSPublicationsBooks(.(2020 4. IntegratedSolidWasteManagementEngineeringPrinciplesandManagement,Tchobanoglous, McGrawHill(2014). 5. SolidWasteManagement(SWM),VasudevanRajaram,PHIlearning privatelimited, 2016
REFERENCE BOOKS	1. MunicipalSolidWasteManagement,ChristianLudwig,SamuelStucki,StefanieHellweg, SpringerBerlinHeisenberg, 2012 2. Solid Waste Management Bhide A. D Indian National ScientificDocumentationCentre,NewDelhi Edition1983ASIN:B0018MZ0C2 3. Solid WasteTechobanoglousGeorge;Kreith,FrankMcGrawHill Publication,NewDelhi2002,ISBN 9780071356237 4. EnvironmentalStudiesManjunathD.L.PearsonEducationPublication,New Delhi, 20061SBN-I3: 978-8131709122 5. SolidWasteManagementSasikumarK.PHIlearning,New Delhi,2009ISBN8120338693
WEB SOURCES	1. https://www.meripustak.com/Integrated-Solid-Waste-Management- Engineering-Principles-And-Management-Issues-125648 2. https://testbook.com/learn/environmental-engineering-solid-waste-management/ 3. https://www.meripustak.com&gclid=Cj0KCQjwuuKXBhCRARIsA-gM0iVpismAJN93CHA1sX6NuNeOKLXfQJ_jxHCOVH3QXjJ1iACq30KofoaAmFsEALw_wcB 4. https://images.app.goo.gl/tYiW2gUPfS2cxdD28 5. https://amzn.eu/d/5VUSTDI

COURSEOUTCOMES:

Atthe end ofthecourse,the studentwillbeableto:

CO1	Gainedknowledgeinsolidwastemanagement	**K1**
CO2	Equipped to takeup related job bygainingindustryexposure	**K5**
CO3	Developentrepreneurialskills	**K3**
CO4	Willbeabletoanalyzeandmanagethestatusofthesolidwastesinthenearby areas	**K4**
CO5	Adequatelysensitizedinmanagingsolidwastesinandaround his/herlocality	**K5**
K1-Remember;K2–Understand;K3-Apply;K4-Analyze;K5-Evaluate;		

MAPPINGWITHPROGRAMOUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specificoutcomes**(PSO)** inthe 3-pointscaleof STRONG(3), MEDIUM(2)andLOW(1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	2	3	3	3	2	2	2	2	2	3
CO2	2	3	3	2	2	2	3	3	3	2
CO3	2	3	2	2	2	2	3	3	3	2
CO4	3	2	2	2	2	3	3	3	3	2
CO5	2	3	3	2	2	2	3	3	2	3

Strong(3)Medium(2)andLow (1)

Elective- 15.SEWAGE ANDWASTEWATERTREATMENTAND		**II YEAR–THIRDSEMESTER**						
Subject Code	**SubjectName**	**Category**	**L**	**T**	**P**	**Credits**	**Inst. Hours**	**Marks**
23PHYE305	**SEWAGE AND WASTE WATERTREATMENT AND REUSE**	ELECTIVE	3			3	3	75
Pre-Requisites								
Basicknowledgeofclassificationofsewageandsolidwaste anditsharmfuleffects.								
Learning Objectives								

- Togainbasicknowledge insewageandwastewaterTreatmentprocedures
- To gain industryexposure and beequippedto takeup job.
- Toharness entrepreneurialskills.
- Toanalyzethestatusofsewage andwastewatermanagementinthenearbyareas.
- To sensitizethe importanceof healthypracticesinwaste watermanagement.

UNITS	CourseDetails
UNIT I: RECOVERY & REUSEOF WATER	Recovery & Reuse of water from Sewage and Waste water: Methods ofrecovery: Flocculation - Sedimentation - sedimentation with coagulation -Filtration - sand filters - pressure filters - horizontal filters - vector controlmeasuresinindustries-chemicalandbiologicalmethodsofvectoreradication
UNIT II:DISINFECTION	Disinfection:Introduction to disinfection and sterilization: Disinfectant - UV radiation - Chlorination - Antisepsis - Sterilant - Aseptic and sterile - BacteriostaticandBactericidal- factorsaffecting disinfection.
UNIT III:CHEMICAL DISINFECTION	Chemical Disinfection: Introduction - Theory of Chemical Disinfection - Chlorination Other Chemical Methods - Chemical Disinfection TreatmentsRequiring - Electricity - Coagulation/Flocculation Agents as Pretreatment -DisinfectionBy-Products(DBPs)
UNIT IV: PHYSICAL DISINFECTION	Physical Disinfection: Introduction - Ultraviolet Radiation - Solar Disinfection-HeatTreatment-FiltrationMethods-Distillation-ElectrochemicalOxidation WaterDisinfection byMicrowave Heating.
UNIT V:INDUSTRIALVISIT	Industrialvisit–datacollectionandanalysis-presentation
UNITVI: PROFESSIONAL COMPONENTS	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and CommunicationSkill Enhancement, Social Accountabilityand Patriotism
TEXT BOOKS	1. Drinkingwateranddisinfectiontechnique,AnirudhhaBalachandra.CRC press (2013) 2. DesignofWaterandWastewaterTreatmentSystems(CV-424/434),Shashi Bushan,(2015)Jain Bros 3. IntegratedWaterResourcesManagement,SarbhukanMM,CBSPUBLICATION(2013) 4. C.S.Rao,EnvironmentalPollutionControlEngineering,NewAgeInternational,2007 5. S.P.Mahajan,Pollutioncontrolinprocessindustries,27thEd.TataMcGrawHill PublishingCompanyLtd., 2012.
REFERENCE BOOKS	1. Handbook of Water and Wastewater Treatment Plant Operations,Frank.RSpellman, CRCPress,2020 2. WastewaterTreatmentTechnologies,MritunjayChaubey,Wiley,2021. 3. MetcalfandEddy,WastewaterEngineering,4thed.,McGrawHillHigher Edu., 2002. 4. W.WesleyEckenfelder,Jr.,IndustrialWaterPollutionControl,2ndEdn., McGraw HillInc.,1989 5. Lancaster,GreenChemistry:AnIntroductoryText,2ndedition,RSCpublishing, 2010.

WEBSOURCES	1. https://www.google.co.in/books/edition/Drinking_Water_DisinfectionTechniques/HVbNBQAAQBAJ?hl=en 2.https://www.meripustak.com/Integrated-Solid-Waste-Management-Engineering-Principles-And-Management-Issues-125648? 3.https://www.meripustak.com&gclid=Cj0KCQjwuuKXBhCRARIsAC-gM0iVpismAJN93CHA1sX6NuNeOKLXfQJjxHCOVH3QXjJ1iACq30KofoaAmFsEALw_wcB 4. https://www.meripustak.com&gclid=Cj0KCQjwuuKXBhCRARIsAC-gM0iVpismAJN93CHA1sX6NuNeOKLXfQJjxHCOVH3QXjJ1iACq30KofoaAmFsEALw_wcB 5. https://www.amazon.in/Design-Wastewater-Treatment-Systems-CV-424/dp/B00IG2PI6K/ref=asc_df_B00IG2PI6K/?tag=googleshopmob-21&linkCode=df0&hvadid=397013004690&hvpos=&hvnetw=g&hvrand=4351305881865063672&hvpone=&hvptwo=&hvqmt=&hvdev=m&hvdvcmdl=&hvlocint=&hvlocphy=9061971&hvtargid=pla-890646066127&psc=1&ext_vrnc=hi

COURSEOUTCOMES:

Atthe endof thecourse, thestudentwillbeable to:

CO1	Gainedknowledgein solidwaste management	**K1**
CO2	Equipped to takeup relatedjob bygainingindustryexposure	**K5**
CO3	Developentrepreneurialskills	**K3**
CO4	Willbeable to analyze and managethestatus of thesolidwastesin thenearbyareas	**K4**
CO5	Adequatelysensitized inmanagingsolidwastesin and aroundhis/herlocality	**K5**

K1-Remember;K2–Understand; K3-Apply;K4-Analyze;K5-Evaluate;

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	2	3	3	3	2	3	2	3	2
CO2	2	3	2	2	3	3	2	3	2	2
CO3	2	2	2	2	2	3	3	3	3	2
CO4	3	2	3	3	2	3	3	3	3	2
CO5	2	2	2	2	3	3	2	2	2	2

Strong(3)Medium (2)andLow(1)

Elective- VI (Industry/Entrepreneurship)80%P20%T. CHARACTERIZATON OF MATERIALS	II YEAR–FOURTH SEMESTER

Subject Code	Subject Name	Category	L	T	P	Credits	Inst.Hours	Marks
23PHYE404	**CHARACTERIZATON OF MATERIALS**	ELECTIVE	1		3	3	4	75

Pre-Requisites
FundamentalsofHeatandThermodynamics,BasicsofOpticalsystems,Microscopicsystems,Electrical measurementsandFundamentalsofSpectroscopy.
LearningObjectives
➢ To make the students learn someimportantthermalanalysistechniques. ➢ To make the students understand thetheoryofimageformation inan opticalmicroscopeandto introduceotherspecialized microscopictechniques. ➢ Tomakethestudentslearnandunderstand theprincipleofworkingof electronmicroscopes. ➢ To make the students understand some important electrical and optical characterizationtechniquesforsemiconductingmaterials. ➢ Thebasics ofx-raydiffraction techniquesand someimportantspectroscopictchniques.

UNITS	Coursedetails
UNIT I THERMAL ANALYSIS	Introduction–thermogravimetricanalysis(TGA)–instrumentation–determinationofweightlossanddecompositionproducts–differentialthermalanalysis(DTA) –coolingcurves–differentialscanningcalorimetry (DSC)–instrumentation–specificheatcapacitymeasurements–Applications.
UNIT II ABSORPTION AND EMISSION SPECTROSCOPY MICROSCOPIC METHODS	Atomic, molecular spectroscopy – Electromagnetic radiation – pH meter, Conductive meter, Flame Photo meter. Working principle and Instrumentation of Inductively coupled plasma spectrometer(ICP) Optical Microscopy: optical microscopy techniques – fluorescence microscopy – confocal microscopy objectives – quantitative metallography – image analyzer.
UNIT III ELECTRONMICROSCOPYAND ATOMIC FORCE MICROSCOPY	Scanning Electron Microscopy (SEM), FESEM with EDAX, TEM and Atomic forcemicroscopy(AFM), – working principle and Instrumentation –sample preparation–Data -collection, processing and analysis.
UNIT IV ELECTRICAL METHODSAND OPTICAL CHARACTERISATION	Two probeandfourprobe methods – Hall probeand measurement– CV characteristics– impurity , concentration–electrochemical C-V profiling – limitations.Photoluminescence–light–matter interaction–instrumentation– Principles and instrumentation for UV-Vis spectrometer

UNIT-V X-RAYAND SPECTROSCOPIC METHODS	FTIR spectroscopy, Raman spectroscopy, NMR –XRD Powder diffractometer –interpretation of diffraction patterns-Indexing - phase identification.
UNIT -VI: **PROFESSIONAL COMPONENTS**	Expert Lectures, Online Seminars WebinarsonIndustrialInteractions/Visits,CompetitiveExaminations,EmployableandCommunicationSkillEnhancement,SocialAccountabilityandPatriotism

TEXTBOOKS	1. R.A.StradlingandP.C.Klipstain.GrowthandCharacterizationofsemiconductors.Adam Hilger,Bristol, 1990. 2. J.A.Belk.Electronmicroscopyandmicroanalysis ofcrystallinematerials.AppliedSciencePublishers,London, 1979. 3. LawrenceE.Murr.Electronand IonmicroscopyandMicroanalysisprinciplesandApplications.Marcel DekkerInc.,NewYork,1991 4. D.KealeyandP.J.Haines.AnalyticalChemistry.VivaBooksPrivateLimited,New Delhi, 2002. 5. Li,Lin,AshokKumarMaterialsCharacterization TechniquesSam Zhang;CRCPress, (2008).
REFERENCE BOOKS	1. Cullity, B.D., and Stock, R.S., "Elements of X-Ray Diffraction‖, Prentice-Hall,(2001). 2. Murphy, Douglas B, Fundamentals of Light Microscopy and ElectronicImaging,Wiley-Liss,Inc. USA, (2001). 3. Tyagi, A.K., Roy, Mainak, Kulshreshtha, S.K., and Banerjee, S., AdvancedTechniques for Materials Characterization, Materials Science Foundations(monographseries), Volumes 49– 51,(2009).Volumes 49 –51, (2009). 4. Wendlandt,W.W.,Thermal Analysis,JohnWiley&Sons,(1986). 5. Wachtman,J.B.,Kalman,Z.H.,CharacterizationofMaterials,ButterworthHeinemann,(1993)
WEBS OURCES	1. https://cac.annauniv.edu/uddetails/udpg_2015/77.%20Mat%20Sci(AC).pdf 2. http://www.digimat.in/nptel/courses/video/113106034/L11.html 3. https://nptel.ac.in/courses/104106122 4. https://nptel.ac.in/courses/118104008 5. https://www.sciencedirect.com/journal/materials-characterization

COURSEOUTCOMES:

Atthe end ofthecourse,the studentwillbeableto:

CO1	DescribetheTGA,DTA,DSCthermalanalysis techniquesandmakeinterpretation of theresults.	**K1, K3**
CO2	Theconceptofimage formation inOptical microscope,developmentsin otherspecializedmicroscopesand theirapplications.	**K2**
CO3	Theworkingprinciple and operation of SEM, TEM and AFM.	**K2, K3**
CO4	Understood Hall measurement, four –probe resistivity measurement, C-V, I-V,Electrochemical, Photoluminescence and electroluminescence experimentaltechniqueswith necessarytheory.	**K3,K4**
CO5	Thetheoryandexperimentalprocedureforx-raydiffraction and someimportantspectroscopic techniquesand theirapplications.	**K4,K5**

K1-Remember;K2–Understand;K3-Apply;K4-Analyze;K5-Evaluate;

MAPPINGWITHPROGRAMOUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specificoutcomes**(PSO)** inthe 3-point scaleofSTRONG (3), MEDIUM(2)andLOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	3	2	2	2	2	2	2	3
CO2	3	3	3	2	2	2	2	2	2	2
CO3	3	3	2	2	2	3	2	2	2	2
CO4	2	2	2	3	2	3	2	2	2	2
CO5	2	2	2	2	2	2	3	2	2	2

Strong(3)Medium(2)andLow (1)

PROJECTWITH VIVA-VOCE

SEMESTER-IV	**23PHYD403-PROJECT**	**Credit:7 Hours:10**

LearningObjectives:

Todevelopskillinbothexperimentalandtheoreticalworkbycarryingoutresearchinselectivearea ofapplied physics.

Courseoutcomes:

Attheendofthecourse,thestudentswill

CO1: Acquirethepracticalknowledgeofunderstandingresearchproblems.

CO2: Gainknowledgebasicprinciplesofvariouscomponentsofresearch

CO3: Applytheprinciplesofchemistryinvariousfields.

CO4: Identifytheappropriatespectral techniques ananalyticaltooltoinvestigatethecharacteristics ofmaterials.

MAPPINGWITHPROGRAMMEOUTCOMES(POs) AND PROGRAMMESPECIFICOUTCOMES(PSOs)

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO1 0**
CO1	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3

SKILL ENHANCEMENT COURSES (SEC)

SEC – I SOLAR ENERGY UTILIZATION		I YEAR–SECOND SEMESTER						
SubjectCode	**SubjectName**	**Category**	**L**	**T**	**P**	**Credits**	**Inst. Hours**	**Marks**
23PHYS206	**SOLAR ENERGY UTILIZATION**	ELECTIVE	3		1	2	4	75

Pre-Requisites
Basicknowledgeofheatenergy, wayoftransferofheat,solarenergy,materialstypes
LearningObjectives
➢ Toimpart fundamental aspects of solarenergyutilization. ➢ Togiveadequateexposuretosolarenergyrelatedindustries ➢ Toharnessentrepreneurship skills ➢ Tounderstandthedifferenttypesofsolarcellsandchannelizingthemtothedifferentsectors ofsociety ➢ Todevelop anindustrialist mindsetbyutilizingrenewablesourceofenergy

UNITS	CourseDetails
UNITI: HEAT TRANSFER &RADIATIONANALYSIS	Conduction,Convection and Radiation SolarRadiationattheearth'ssurface-Determinationof solartime– Solarenergymeasuringinstruments.
UNITII: SOLARCOLLECTORS	PhysicalprinciplesofconversionofsolarradiationintoheatflatPlatecollectors – Generalcharacteristics–Focusingcollectorsystems–Thermal performanceevaluationofopticalloss.
UNIT III: SOLAR HEATERS	Typesofsolarwaterheater-Solarheatingsystem– Collectorsandstoragetanks– Solarponds – Solarcoolingsystems.
UNIT IV:SOLARENERGY CONVERSION	PhotoVoltaicprinciples–Typesofsolarcells– Crystallinesilicon/amorphoussiliconandThermo-electricconversion-process Flowofsiliconsolarcells-differentapproachesontheprocess-texturization,diffusion,Antireflectivecoatings, metallization.
UNIT V:NANOMATERIALS INFUEL CELLAPPLICATIONS	Use of nanostructures and nanomaterials in fuel celltechnology - highandlowtemperaturefuelcells,cathodeandanodereactions,fuelcellcatalysts,electrolytes,ceramiccatalysts.UseofNanotechnologyin hydrogen production and storage.Industrialvisit–data collectionandanalysis-presentation
UNIT VI: PROFESSIONAL COMPONENTS	ExpertLectures,OnlineSeminars-WebinarsonIndustrialInteractions/Visits,CompetitiveExaminations,EmployableandCommunicationSkillEnhancement, Social Accountability and Patriotism

TEXTBOOKS	1. Solarenergyutilization-G.D.Rai–Khanna publishers –Delhi1987. 2. Maheshwar Sharon, Madhuri Sharon, Carbon –Nano formsand Applications‖,McGraw-Hill,2010. 3. SoterisA.Kalogirou,,,SolarEnergyEngineering:ProcessesandSystems‟, AcademicPress,London,2009 4. TiwariG.N,–SolarEnergy –FundamentalsDesign,Modellingand applications,NarosaPublishingHouse,New Delhi, 2002 5. SukhatmeS.P.SolarEnergy,TataMcGrawHillPublishingCompanyLtd.,New Delhi, 1997.
REFERENCE BOOKS	1. Energy–An IntroductiontoPhysics –R.H.Romer,W.H.Freeman.(1976) 2. Solarenergythermal processes – John A.Drife and William. (1974) 3. JohnW.Twidell&AnthonyD.Weir,_RenewableEnergyResources,2005 4. JohnA.Duffie,WilliamA.Beckman,SolarEnergy:ThermalProcesses,4th Edition, johnWileyand Sons, 2013 5. Duffie,J.A.,Beckman,W.A.,–SolarEnergy ThermalProcess‖,JohnWiley AndSons,2007.
WEB SOURCES	1. https://pdfs.semanticscholar.org/63a5/a69421b69d2ce9f359bbfc86c63556f9a4fb 2. https://books.google.vg/books?id=l-XHcwZo9XwC&sitesec=buy&source=gbs_vpt_re 3. www.nptel.ac.in/courses/112105051 4. www.freevideolectures.com 5. http://www.e-booksdirectory.com

COURSEOUTCOMES:

Atthe endof thecourse,thestudentwill beableto:

CO1	Gainedknowledgein fundamentalaspects of solarenergyutilization	**K1**
CO2	Equipped to takeup related job bygainingindustryexposure	**K3**
CO3	Developentrepreneurialskills	**K5**
CO4	Skilledtoapproachthe needysocietywith different typesofsolarcells	**K4**
CO5	Gainedindustrialistmindset byutilizingrenewablesourceofenergy	**K2, K3**
K1-Remember;K2–Understand;K3-Apply;K4-Analyze;K5-Evaluate;		

MAPPINGWITHPROGRAMOUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specificoutcomes**(PSO)** inthe 3-pointscaleof STRONG(3), MEDIUM(2)andLOW(1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	2	3	3	3	2	2	2	3	2
CO2	2	3	2	2	3	3	2	3	2	2
CO3	2	3	2	2	2	2	3	3	3	2
CO4	2	2	2	3	2	3	2	3	3	2
CO5	2	2	3	2	3	3	3	3	3	3

Strong(3)Medium(2)andLow (1)

SEC – II PHYSICS FOR MEDICAL INSTRUMENTATION	II YEAR–THIRD SEMESTER

Subject Code	SubjectName	Category	L	T	P	Credits	Inst.Hours	Marks
23PHYS3O6	**PHYSICS FOR MEDICAL INSTRUMENTATION**	SEC-II	3			2	3	75

LEARNING OBJECTIVES:

- To understand the working principles of various instruments in bio-medical field
- To update the knowledge of various bio-instrumentation techniques.

UNITS	Course Details
Unit I: BIO-ELECTRICPOTENTIALS	Resting and action potentials – Propagation of action potentials – Bioelectric potentials – Biopotential Electrodes – Types of Electrodes. Principle,Instrumentation and working of Electrocardiogram (ECG) – Electroencephalogram (EEG) – Electromyogram (EMG) .
Unit-II: X-RAYS AND CT	Electromagnetic Spectrum – Production of X-Rays–X-Ray Spectrum– Characteristic X-Ray – Coolidge Tube – X-ray Tube Design. CT-Scan: Principle, equipments, Generation, scan parameters, Image reconstruction, Image display, Image Quality, artefacts, control console etc
Unit III: IMAGINGEQUIPMENTS	Ultrasonic imaging – Reflection –Scattering-A mode display-B mode display –Ultrasonic imaging instrumentation – Biomedical applications. Magnetic Resonance imaging (MRI)- Principles – Instrumentation – Advantages of MRI.
UNIT-IV:RADIATION PHYSICS	Radiation Units – Exposure – Absorbed Dose – Rad to Gray – Kera Relative Biological Effectiveness –Effective Dose – Sievert (Sv) – Inverse Square Law – Interaction of radiation with Matter – Linear Attenuation Coefficient – Radiation Detectors –Thimble Chamber – Condenser Chambers – Geiger Counter – Scintillation Counter
UNIT-V: APPLIEDPHYSICS FORPHYSIOTHERAPY	Introduction to Therapeutic Energies – Thermal, Mechanical, Electrical, Electromagnetic and Magnetic-Definition, description, physiological, pathological effects. Medical Instrumentation For Physical Therapy: Brief description of generation, circuit diagrams and testing. Low frequency currents, Direct currents, Medium frequency currents.

TEXT BOOKS	1. Biomedical Instrumentation, T.Rajalakshmi, First Edition, 2008. 2. Bio medical Instrumentation, M.Arumugam , Fourth Reprint,2000. 3. Animal Physiology, .P.S. Verma, B.S. Tyagi and V.K.Agarwal, 2005. S.Chand & Company Ltd, New Delhi. 4. Biological spectroscopy by Iain D.Campbell, Raymond A.Dwek
REFERENCE BOOKS	1. Farr's Physics for Medical imaging, Penelope Allsiy, Rpberts, Jerry R.Villiams, Saunders, Elsevier, Second Edition, 2008. 2. Handbook of Biomedical instrumentation, R.S. Khandpur,2007. 3. The Physics of Radiation Therapy,FiazM.Khan, 2006. 4. Nuclear Medicine physics, Ramesh Chandra, 5th Edition, Lea and Febiger
WEB SOURCES	. 1. https:nptel.ac.in/courses/108/103/108103157/ 2. https://www.studocu.com/en/course/university-of-technology-sydney/medical-devices-and-diagnostics/225692 3. https://www.technicalsymposium.com/alllecturenotes_biomed.html 4. https://lecturenotes.in/notes/17929-note-for-biomedical-instrumentation-bi-by-deepraj-adhikary/78 5. https://www.modulight.com/applications-medical/

COURSE OUTCOMES:

By the end of the course, the students will be able to

CO1	Understand the structure and physiological functioning of various organ systems of human body
CO2	Master the common bio-separation techniques used for clinical applications
CO3	Operate various medical equipments working on the principles of bio-electric potentials
CO4	Understand the basic principles and operations of various imaging equipments used in the clinical field

MAPPING WITH PROGRAMME OUTCOMES (POs) and PROGRAMME SPECIFIC OUTCOMES (PSOs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	3	3	3	3	3	3	3	3	3	3	3		3		3	3	3
CO2	3	3	3	3	3	3	3	3	3	3	3	3		3		3	3	3
CO3	3	3	3	3	3	3	3	3	3	3	3	3		3		3	3	3
CO4	3	3	3	3	3	3	3	3	3	3	3	3		3		3	3	3

SEC III: 23PHYS405 - NUMERICAL METHODS AND COMPUTER PROGRAMMING	II YEAR - FOURTH SEMESTER

Subject Code	Subject Name	Category	L	T	P	Credits	Inst. Hours	Marks
23PHYS405	NUMERICAL METHODS AND COMPUTER PROGRAMMING	SEC-III	3		1	2	4	75

Pre-Requisites
Prior knowledge on computer and basic mathematics
Learning Objectives
To make students to understand different numerical approaches to solve a problem. To understand the basics of programming

UNITS	Course Details
UNIT I: SOLUTIONS OF EQUATIONS	Roots of polynomials, nonlinear algebraic equations and transcendental equations using Bisection and Newton-Raphson methods.
UNIT II: LINEAR SYSTEM OF EQUATIONS	Simultaneous linear equations and their matrix representation–Gaussian elimination method – Gauss Jordan method – Inverse of a matrix by Gauss elimination method.
UNIT III: INTERPOLATION AND CURVE FITTING	Interpolation with equally spaced points - Newton forward and backward interpolation - Curve fitting – Method of least squares – Fitting a polynomial.
UNIT IV: DIFFERENTIATION AND INTEGRATION	Numerical differentiation – Euler and RungaKuttamethods – Numerical integration – Trapezoidal rule – Simpson's rule.
UNIT V: PROGRAMMING WITH C	Flow-charts – Integer and floating point arithmetic expressions – Built-in functions –Zeros of polynomials/non-linear equations by the Newton-Raphson method - Trapezoidal and Simpson's Rules.
UNIT VI: PROFESSIONAL COMPONENTS	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

TEXT BOOKS	1. V. Rajaraman, 1993, Computer oriented Numerical Methods, 3rd Edition. PHI, New Delhi 2. M. K .Jain, S. R. Iyengar and R. K. Jain, 1995, Numerical Methods for Scientific and Engineering Computation, 3rd Edition, New Age Intl., New Delhi 3. S. S. Sastry, Introductory Methods of Numerical analysis, PHI, 4. F. Scheid, 1998, Numerical Analysis, 2nd Edition, Schaum's series, McGraw Hill, New York 5. W. H. Press, S. A. Teukolsky, W. T. Vetterling and B. P. Flannery, 1992, Numerical Recipes in FORTRAN, 2nd Edition, Cambridge Univ. Press
REFERENCE BOOKS	1. S. D. Conte and C. de Boor, 1981, Elementary Numerical analysis-an algorithmic approach, 3rd Edition, McGraw Hill,) 2. B. F. Gerald, and P. O. Wheatley, 1994, Applied Numerical analysis, 5th Edition, Addison-Wesley, MA. 3. B. Carnagan, H. A. Luther and J. O. Wilkes, 1969, Applied Numerical Methods, Wiley, New York. 4. S. S. Kuo, 1996, Numerical Methods and Computers, Addison-Wesley. 5. V. Rajaraman, Programming in FORTRAN / Programming in C, PHI, New Delhi
WEB SOURCES	1. https://www.scribd.com/doc/202122350/Computer-Oriented-Numerical-Methods-by-V-RajaRaman 2. https://www.scirp.org/(S(lz5mqp453edsnp55rrgjct55))/reference/referencespapers.aspx?referenceid=1682874 3. https://nptel.ac.in/course/122106033/ 4. https://nptel.ac.in/course/103106074/

COURSE OUTCOMES:

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

CO1	Recall the transcendental equations and analyze the different root finding methods. Understand the basic concept involved in root finding procedure such as Newton Raphson and Bisection methods, their limitations.	K1, K2
CO2	Relate Simultaneous linear equations and their matrix representation Distinguish between various methods in solving simultaneous linear equations.	**K5**
CO3	Understand, how interpolation will be used in various realms of physics and Apply to some simple problems Analyze the newton forward and backward interpolation	**K2, K3**
CO4	Recollect and apply methods in numerical differentiation and integration. Assess the trapezoidal and Simson's method of numerical integration.	**K3, K4**
CO5	Understand the basics of C-programming and conditional statements.	**K2**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) andLOW (1)

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	2	3	1	1	2	3	2	2	3
CO2	3	2	3	1	1	2	3	2	2	3
CO3	3	2	3	1	1	2	3	2	2	3
CO4	3	2	3	1	1	2	3	2	2	3
CO5	3	2	3	1	1	2	3	2	2	3