



(Accredited with 'A⁺' Grade by NAAC)

M.Sc. Physics
(Two Year Programme)

Regulations & Curriculum (2023 - 2024)

Department of Physics
DST – FIST Supported

**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 centers 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** is an 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 will be carried out during the summer vacation of the first year and marks will be included in the Third Semester Marks 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 Online Courses (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

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

where, C_i is the Credit earned for the Course i in any semester;

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.

$$CGPA = \frac{\sum_{i=1}^m \sum_{j=1}^n C_i G_{ij}}{\sum_{i=1}^m \sum_{j=1}^n C_i}$$

where, **C_i** is the Credit earned for the Course **i** in any semester;
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.
m is 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 once during 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.** Not with standing 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.



ANNAMALAI UNIVERSITY
DEPARTMENT OF PHYSICS
M.Sc Physics (Two Year Programme)
Programme Code: SPHY21

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

Part	Course Code	Course Title	Credit	Hours/Week	Maximum Marks		
					CIA	ESE	Total
		SEMESTER – I					
A	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 Material Science	3	5	25	75	100
	23PHYE105	Elective– II Energy Physics	3	5	25	75	100
Total			20	30			500
SEMESTER – II							
A	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 Advanced Optics	3	4	25	75	100
	23PHYE205	Elective– IV Microprocessor 8085 and Microcontroller 8051	3	4	25	75	100
B (i)	23TSSC200	Academic Writing Skills	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 Physics of Nanoscience and Technology	3	3	25	75	100
B (i)	23PHYS306	SEC- II Physics for Medical Instrumentation	2	3	25	75	100
B (ii)	23PHYI307	Summer Internship / Industrial Activity	2	-			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 Characterization of Materials	3	4	25	75	100
B (i)	23PHYS405	SEC– III Numerical Methods and Computer Programming	2	4	25	75	100
C	23PHYX406	Extension Activity (NSS)	1	-			100
		Total	23	30			600
		Total Credits / Hours	91	120			2400

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

Note:

- Students shall take Department Electives and Skill Enhancement Courses (SECs) from a range of choices available.
- * Internship will be carried out during the summer vacation of the first year and marks will be included in the Third Semester Marks 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
		Sewage and Waste Water Treatment and 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
Bi	5	SEC	3 x 2	06
Bii	6	Internship	1 x 2	02
C	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.

TANSCH 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
PSO5	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 - CLASSICAL MECHANICS AND RELATIVITY	I YEAR - FIRST SEMESTER
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Subject Code	Subject Name	Category	L	T	P	Credits	Inst. Hours	Marks
23PHYC101	CLASSICAL MECHANICS AND RELATIVITY	Core	6	1		5	7	75

Pre-Requisites
Fundamentals of mechanics, Foundation in mathematical methods.
Learning Objectives
➤ To understand fundamentals of classical mechanics. ➤ To understand Lagrangian formulation of mechanics and apply it to solve equation of motion. ➤ To understand Hamiltonian formulation of mechanics and apply it to solve equation of motion. ➤ To discuss the theory of small oscillations of a system. ➤ To learn the relativistic formulation of mechanics of a system.

UNITS	Course Details
UNIT I: PRINCIPLES OF CLASSICAL MECHANICS	Mechanics of a single particle – mechanics of a system of particles – conservation laws for a system of particles – constraints – holonomic & non-holonomic constraints – generalized coordinates – configuration space – transformation equations – principle of virtual work.
UNIT II: LAGRANGIAN FORMULATION	D'Alembert's principle – Lagrangian equations of motion for conservative systems – applications: (i) simple pendulum (ii) Atwood's machine (iii) projectile motion.
UNIT III: HAMILTONIAN FORMULATION	Phase space – cyclic coordinates – conjugate momentum – Hamiltonian function – Hamilton's canonical equations of motion – applications: (i) simple pendulum (ii) one dimensional simple harmonic oscillator (iii) motion of particle in a central force field.
UNIT IV: SMALL OSCILLATIONS	Formulation of the problem – transformation to normal coordinates – frequencies of normal modes – linear triatomic molecule.
UNIT V: RELATIVITY	Inertial and non-inertial frames – Lorentz transformation equations – length contraction and time dilation – relativistic addition of velocities Einstein's mass-energy relation – Minkowski's space – four vectors – position, velocity, momentum, acceleration and force in vector notation and their transformations
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. H. Goldstein, 2002, <i>Classical Mechanics</i>, 3rd Edition, Pearson Edu. 2. J. C. Upadhyaya, <i>Classical Mechanics</i>, Himalaya Publishing Co. New Delhi. 3. R. Resnick, 1968, <i>Introduction to Special Theory of Relativity</i>, Wiley Eastern, New Delhi. 4. R. G. Takwala and P.S. Puranik, <i>Introduction to Classical Mechanics</i> – Tata – McGraw Hill, New Delhi, 1980. 5. N. C. Rana and P.S. Joag, <i>Classical Mechanics</i> - Tata McGrawHill, 2001
REFERENCE BOOKS	1. K. R. Symon, 1971, <i>Mechanics</i>, Addison Wesley, London. 2. S. N. Biswas, 1999, <i>Classical Mechanics</i>, Books & Allied, Kolkata. 3. Gupta and Kumar, <i>Classical Mechanics</i>, Kedar Nath. 4. T.W.B. Kibble, <i>Classical Mechanics</i>, ELBS. 5. Greenwood, <i>Classical Dynamics</i>, PHI, New Delhi.
WEB SOURCES	1. http://poincare.matf.bg.ac.rs/~zarkom/Book_Mechanics_Goldstein_Classical_Mechanics_optimized.pdf 2. https://pdfcoffee.com/classical-mechanics-j-c-upadhyay-2014-edition-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

COURSE OUTCOMES:

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

CO1	Understand the fundamentals of classical mechanics.	K2
CO2	Apply the principles of Lagrangian and Hamiltonian mechanics to solve the equations of motion of physical systems.	K3
CO3	Apply the principles of Lagrangian and Hamiltonian mechanics to solve the equations of motion of physical systems.	K3, K5
CO4	Analyze the small oscillations in systems and determine their normal modes of oscillations.	K4, K5
CO5	Understand and apply the principles of relativistic kinematics to the mechanical systems.	K2, K3
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) and LOW (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 - LINEAR AND DIGITAL ICs & APPLICATIONS	I YEAR - FIRST SEMESTER
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Subject Code	Subject Name	Category	L	T	P	Credits	Inst. Hours	Marks
23PHYC102	LINEAR AND DIGITAL ICs AND APPLICATIONS	Core	6	1		5	7	75

Pre-Requisites

Knowledge of semiconductor devices, basic concepts of digital and analog electronics

Learning Objectives

- To introduce the basic building blocks of linear integrated circuits.
- To teach the linear and non-linear applications of operational amplifiers.
- To introduce the theory and applications of PLL.
- To introduce the concepts of waveform generation and introduce one special function ICs.
- Exposure to digital ICs

UNITS	Course Details
UNIT I: INTEGRATED CIRCUITS AND OPERATIONAL AMPLIFIER	Introduction, Classification of IC's, basic information of Op-Amp 741 and its features, the ideal Operational amplifier, Op-Amp internal circuit and Op-Amp Characteristics.
UNIT II: APPLICATIONS OF OP-AMP	LINEAR APPLICATIONS OF OP-AMP: Solution to simultaneous equations and differential equations, Instrumentation amplifiers, V to I and I to V converters. NON-LINEAR APPLICATIONS OF OP-AMP: Sample and Hold circuit, Log and Antilog amplifier, multiplier and divider, Comparators, Schmitt trigger, Multivibrators, Triangular and Square waveform generators.
UNIT III: ACTIVE FILTERS & TIMER AND PHASE LOCKED LOOPS	ACTIVE FILTERS: Introduction, Butterworth filters – 1st order, 2nd order low pass and high pass filters, band pass, band reject and all pass filters. TIMER AND PHASE LOCKED LOOPS: Introduction to IC 555 timer, description of functional diagram, monostable and astable operations and applications, Schmitt trigger, PLL - introduction, basic principle, phase detector/comparator, voltage controlled oscillator (IC 566), low pass filter, monolithic PLL and applications of PLL
UNIT IV: VOLTAGE REGULATOR & D to A AND A to D CONVERTERS	VOLTAGE REGULATOR: Introduction, Series Op-Amp regulator, IC Voltage Regulators, IC 723 general purpose regulators, Switching Regulator. D to A AND A to D CONVERTERS: Introduction, basic DAC techniques - weighted resistor DAC, R-2R ladder DAC, inverted R-2R DAC, A to D converters -parallel comparator type ADC, counter type ADC, successive approximation ADC and dual slope ADC, DAC and ADC Specifications.
UNIT V: CMOS LOGIC, COMBINATIONAL CIRCUITS USING TTL 74XX ICs & SEQUENTIAL CIRCUITS USING TTL 74XX ICs	CMOS LOGIC: CMOS logic levels, MOS transistors, Basic CMOS Inverter, NAND and NOR gates, CMOS AND-OR-INVERT and OR-AND-INVERT gates, implementation of any function using CMOS logic. COMBINATIONAL CIRCUITS USING TTL 74XX ICs: Study of logic gates using 74XX ICs, Four-bit parallel adder (IC 7483), Comparator (IC 7485), Decoder (IC 74138, IC 74154), BCD to 7-segment decoder (IC 7447), Encoder (IC 74147), Multiplexer (IC 74151), Demultiplexer (IC 74154). SEQUENTIAL CIRCUITS USING TTL 74XX ICs: Flip Flops (IC 7474, IC 7473), Shift Registers, Universal Shift Register (IC 74194), 4-bit asynchronous binary counter (IC 7493).

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. D. Roy Choudhury, Shail B. Jain (2012), Linear Integrated Circuit, 4th edition, New Age International Pvt. Ltd., New Delhi, India 2. Ramakant A. Gayakwad, (2012), OP-AMP and Linear Integrated Circuits, 4th edition, Prentice Hall / Pearson Education, New Delhi. 3. B.L. Theraja and A.K. Theraja, 2004, A Textbook of Electrical technology, S.Chand & Co. 4. V.K. Mehta and Rohit Mehta, 2008, Principles of Electronics, S Chand & Co, 12th Edition. 5. V. Vijayendran, 2008, Introduction to Integrated electronics (Digital & Analog), S. V iswanathan Printers & Publishers Private Ltd, Reprint. V.
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REFERENCE BOOKS	1. Sergio Franco (1997), Design with operational amplifiers and analog integrated circuits, McGraw Hill, New Delhi. 2. Gray, Meyer (1995), Analysis and Design of Analog Integrated Circuits, Wiley International, New Delhi. 3. Malvino and Leach (2005), Digital Principles and Applications 5th Edition, Tata McGraw Hill, New Delhi 4. Floyd, Jain (2009), Digital Fundamentals, 8th edition, Pearson Education, New Delhi. 5. Integrated Electronics, Millman & Halkias, Tata McGraw Hill, 17th Reprint (2000)
WEB SOURCES	1. https://nptel.ac.in/course.html/digital circuits/ 2. https://nptel.ac.in/course.html/electronics/operational amplifier/ 3. https://www.allaboutcircuits.com/textbook/semiconductors/chpt-7/field-effect-controlled-thyristors/ 4. https://www.electrical4u.com/applications-of-op-amp/ 5. https://www.geeksforgeeks.org/digital-electronics-logic-design- tutorials/

COURSE OUTCOMES:

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

CO1	about the basic concepts for the circuit configuration for the design of linear integrated circuits and develops skill to solve problems	K1, K5
CO2	skills to design linear and non-linear applications circuits using Op-Amp and design the active filters circuits.	K3
CO3	knowledge about PLL, and develop the skills to design the simple circuits using IC 555 timer and can solve problems related to it.	K1, K3
CO4	about various techniques to develop A/D and D/A converters.	K2
CO5	the knowledge about the CMOS logic, combinational and sequential circuits	K1, K4
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) and LOW (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) and Low (1)

Paper - 3 - PRACTICAL I	I YEAR - FIRST SEMESTER
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SubjectCode	Subject Name	Category	L	T	P	Credits	Inst. Hours	Marks
23PHYP103	PRACTICAL I	Core			6	4	6	75

Pre-Requisites
Knowledge and hands on experience of basic general and electronics experiments of Physics
Learning Objectives
➤ To understand the concept of mechanical behavior of materials and calculation of same using appropriate equations. ➤ To calculate the thermodynamic quantities and physical properties of materials. ➤ To analyze the optical and electrical properties of materials.

Course Details

(Any Twelve Experiments)

1. Determination of Young's modulus and Poisson's ratio by Hyperbolic fringes - Cornu's Method.
2. Determination of Rydberg's Constant - Hydrogen Spectrum.
3. Measurement of Band gap energy- Thermistor.
4. Determination of Compressibility of a liquid using Ultrasonics.
5. Determination of Wavelength, Separation of wavelengths - Michelson Interferometer.
6. GM counter – Characteristics, inverse square law and absorption coefficient.
7. Measurement of Conductivity - Four probe method.
8. Measurement of wavelength of Diode Laser / He – Ne Laser using Diffraction grating.
9. Construction of relaxation oscillator using UJT.
10. Mathematical operation using IC 741.
11. V- I Characteristics of different colours of LED.
12. Study of attenuation characteristics of Wien's bridge network and design of Wien's bridge oscillator using Op-Amp.
13. Study of attenuation characteristics of Phase shift network and design of Phase shift oscillator using Op-Amp.
14. Construction of Schmidt trigger circuit using IC 741 for a given hysteresis- application assquarer.
15. Construction of square wave Triangular wave generator using IC 741.
16. Construction of Op-Amp- 4 bit Digital to Analog converter (Binary Weighted and R/2R ladder type).
17. Study of R-S, clocked R-S and D-Flip flop using NAND gates.
18. Study of J-K, D and T flip flops using IC 7476/7473.
19. Arithmetic operations using IC 7483- 4-bit binary addition and subtraction.
20. Study of Arithmetic logic unit using IC 74181.

TEXT BOOKS	1. Practical Physics, Gupta and Kumar, Pragati Prakasan. 2. Kit Developed for doing experiments in Physics- Instruction manual, R. Srinivasan K.R Priolkar, Indian Academy of Sciences. 3. Electronic Laboratory Primer a design approach, S. Poorna chandra, B. Sasikala, Wheeler Publishing, New Delhi. 4. Electronic lab manual Vol I, K ANavas, Rajath Publishing. 5. Electronic lab manual Vol II, K ANavas, PHI eastern Economy Edition
REFERENCE BOOKS	1. Advanced Practical Physics, S.P Singh, PragatiPrakasan. 2. An advanced course in Practical Physics, D. Chattopadhyay, C.R Rakshit, NewCentral Book Agency Pvt. Ltd 3. Op-Amp and linear integrated circuit, Ramakanth A Gaykwad, Eastern EconomyEdition. 4. A course on experiment with He-Ne Laser, R.S. Sirohi, John Wiley & Sons (Asia) Pvt. Ltd. 5. Electronic lab manual Vol II, Kuriachan T.D, Syam Mohan, Ayodhya Publishing.

COURSE OUTCOMES:

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

CO1	Understand the strength of material using Young's modulus.	K2
CO2	Acquire knowledge of thermal behaviour of the materials.	K1
CO3	Understand theoretical principles of magnetism through the experiments.	K2
CO4	Acquire knowledge about arc spectrum and applications of laser	K1, K3
CO5	Improve the analytical and observation ability in Physics Experiments	K3, K5
CO6	Conduct experiments on applications of FET and UJT	K4
CO7	Analyze various parameters related to operational amplifiers.	K4
CO8	Understand the concepts involved in arithmetic and logical circuits using IC's	K2
CO9	Acquire knowledge about Combinational Logic Circuits and Sequential Logic Circuits	K1
CO10	Analyze the applications of counters and registers	K4
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) and LOW (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) and Low (1)

Paper-4 - MATHEMATICAL PHYSICS	I YEAR – SECOND SEMESTER
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SubjectCode	Subject Name	Category	L	T	P	Credits	Inst. Hours	Marks
23PHYC201	MATHEMATICAL PHYSICS	Core	5	1		5	6	75

Pre-Requisites
Matrices, vectors, differentiation, integration, differential equations
Learning Objectives
➤ To equip students with the mathematical techniques needed for understanding theoretical treatment in different courses taught in their program ➤ To extend their manipulative skills to apply mathematical techniques in their fields ➤ To help students apply Mathematics in solving problems of Physics

UNITS	CourseDetails
UNIT I: LINEAR VECTOR SPACE	Basic concepts – Definitions- examples of vector space – Linear independence - Scalar product- Orthogonality – Gram-Schmidt orthogonalization procedure – linear operators – Dual space- ket and bra notation – orthogonal basis – change of basis – Isomorphism of vector space – projection operator –Eigen values and Eigen functions – Direct sum and invariant subspace – orthogonal transformations and rotation.
UNIT II: COMPLEX ANALYSIS	Review of Complex Numbers -de Moivre's theorem-Functions of a Complex Variable- Differentiability - Analytic functions- Harmonic Functions- Complex Integration- Contour Integration, Cauchy – Riemann conditions – Singular points – Cauchy's Integral Theorem and integral Formula -Taylor's Series - Laurent's Expansion- Zeros and poles – Residue theorem and its Application: Potential theory - (1) Electrostatic fields and complex potentials - Parallel plates, coaxial cylinders and an annular region (2) Heat problems – Parallel plates and coaxial cylinders.
UNIT III: MATRICES	Types of Matrices and their properties, Rank of a Matrix –Conjugate of a matrix - Adjoint of a matrix - Inverse of a matrix - Hermitian and Unitary Matrices - Trace of a matrix- Transformation of matrices - Characteristic equation - Eigen values and Eigen vectors - Cayley–Hamilton theorem – Diagonalization.
UNIT IV: FOURIER TRANSFORMS & LAPLACE TRANSFORMS	Definitions -Fourier transform and its inverse - Transform of Gaussian function and Dirac delta function - Fourier transform of derivatives - Cosine and sine transforms - Convolution theorem. Application: Diffusion equation: Flow of heat in an infinite and in a semi - infinite medium - Wave equation: Vibration of an infinite string and a semi - infinite string. Laplace transform and its inverse Transforms of derivatives and integrals – Differentiation and integration of transforms - Dirac delta functions -Application - Laplace equation: Potential problem in a semi - infinite strip.
UNIT V: DIFFERENTIAL EQUATIONS	Second order differential equation - Sturm-Liouville's theory - Series solution with simple examples - Hermite polynomials - Generating function - Orthogonality properties - Recurrence relations – Legendre polynomials - Generating function - Rodrigue formula – Orthogonality properties - Dirac delta function - One dimensional Green's function and Reciprocity theorem – Sturm - Liouville's type equation in one dimension & their Green's function.
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. George Arfken and Hans J Weber, 2012, Mathematical Methods for Physicists – A Comprehensive Guide (7th edition), Academic press.
2. P.K. Chattopadhyay, 2013, *Mathematical Physics* (2nd edition), New Age, New Delhi
3. A W Joshi, 2017, Matrices and Tensors in Physics, 4th Edition (Paperback), New Age International Pvt. Ltd., India
4. B.D. Gupta, 2009, *Mathematical Physics* (4th edition), Vikas Publishing House, New Delhi.
5. H. K. Dass and Dr. Rama Verma, 2014, Mathematical Physics, Seventh Revised Edition, S. Chand & Company Pvt. Ltd., New Delhi.

REFERENCE BOOKS

1. E. Kreyszig, 1983, Advanced Engineering Mathematics, Wiley Eastern, New Delhi,
2. D. G. Zill and M. R. Cullen, 2006, Advanced Engineering Mathematics, 3rd Ed. Narosa, New Delhi.
3. S. Lipschutz, 1987, Linear Algebra, Schaum's Series, McGraw - Hill, New York
3. E. Butkov, 1968, Mathematical Physics Addison - Wesley, Reading, Massachusetts.
4. P. R. Halmos, 1965, Finite Dimensional Vector Spaces, 2nd Edition, Affiliated East West, New Delhi.
5. C. R. Wylie and L. C. Barrett, 1995, Advanced Engineering Mathematics, 6th Edition, International Edition, McGraw-Hill, New York

WEB SOURCES	1. www.khanacademy.org 2. https://youtu.be/LZnRIOA1_2I 3. http://hyperphysics.phy-astr.gsu.edu/hbase/hmat.html#hmath 4. https://www.youtube.com/watch?v=_2jymuM7OUU&list=PLhkiT_RYTEU27vS_SIED56gNjVJGO2qaZ 5. https://archive.nptel.ac.in/courses/115/106/115106086/
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COURSE OUTCOMES:

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

CO1	Understand use of bra-ket vector notation and explain the meaning of complete orthonormal set of basis vectors, and transformations and be able to apply them	K1, K2
CO2	Able to understand analytic functions, do complex integration, by applying Cauchy Integral Formula. Able to compute many real integrals and infinite sums via complex integration.	K2, K3
CO3	Analyze characteristics of matrices and its different types, and the process of diagonalization.	K4
CO4	Solve equations using Laplace transform and analyze the Fourier transformations of different function, grasp how these transformations can speed up analysis and correlate their importance in technology	K4, K5
CO5	To find the solutions for physical problems using linear differential equations and to solve boundary value problems using Green's function. Apply special functions in computation of solutions to real world problems	K2, K5
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) and LOW (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) and Low (1)

Paper 5 - QUANTUM MECHANICS – I	I YEAR - SECOND SEMESTER
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SubjectCode	Subject Name	Category	L	T	P	Credits	Inst. Hours	Marks
23PHYC202	QUANTUM MECHANICS – I	Core	5	1		5	6	75

Pre-Requisites
Newton's laws of motion, Schrodinger's equation, integration, differentiation.
Learning Objectives
➤ To develop the physical principles and the mathematical background important to quantummechanical descriptions. ➤ To describe the propagation of a particle in a simple, one-dimensional potential. ➤ To formulate and solve the Schrodinger's equation to obtain eigen vectors and energies forparticle in a three - dimensional potential. ➤ To explain the mathematical formalism and the significance of constants of motion, and see their relation to fundamental symmetries in nature ➤ To discuss the Approximation methods like perturbation theory, Variational and WKB ➤ Methods for solving the Schrödinger equation.

UNITS	Course Details
UNIT I: BASIC FORMALISM	Interpretation of the wave function – Time dependent Schrodinger equation – Time independent Schrodinger equation – Stationary states – Ehrenfest's theorem – Linear vector space – Linear operator – Eigen functions and Eigen Values – Hermitian Operator – Postulates of Quantum Mechanics – Simultaneous measurability of observables – General Uncertainty relation
UNIT II: ONE DIMENSIONAL AND THREE- DIMENSIONAL ENERGY EIGENVALUE PROBLEMS	Square – well potential with rigid walls – Square potential barrier – Alpha emission – Bloch waves in aperiodic potential – Kronig - Penny square – well periodic potential – Linear harmonic oscillator: Operator method – Particle moving in a spherically symmetric potential – System of two interacting particles – Hydrogen atom – Rigid rotator.
UNIT III: GENERAL FORMALISM	Dirac notation – Equations of motions – Schrodinger representation – Heisenberg representation – Interaction representation – Coordinate representation – Momentum representation – Symmetries and conservation laws – Unitary transformation – Parity and time reversal
UNIT IV: APPROXIMATION METHODS	Time independent perturbation theory for non-degenerate energy levels – Degenerate energy levels – Stark effect in Hydrogen atom – Ground and excited state – Variation method – Helium atom – WKB approximation – Connection formulae (no derivation) – WKB quantization – Application to Simple harmonic oscillator.
UNIT V: ANGULAR MOMENTUM	Eigen value spectrum of general angular momentum – Ladder operators and their algebra – Matrix representation – Spin angular momentum – Addition of angular momenta – CG Coefficients – Symmetry and anti – symmetry of wave functions – Construction of wave - functions and Pauli's exclusion principle.
UNIT VI: PROFESSIONALCOMPONENTS	Expert Lectures, Online Seminars - Webinars on Industrial Interactions / Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

TEXT BOOKS

1. P. M. Mathews and K. Venkatesan, A Text book of Quantum Mechanics, 2nd edition (37th Reprint), Tata McGraw-Hill, New Delhi, 2010.
2. G. Aruldas, Quantum Mechanics, 2nd edition, Prentice Hall of India, New Delhi, 2009.
3. David J Griffiths, Introduction to Quantum Mechanics. 4th edition, Pearson, 2011.
4. SL Gupta and ID Gupta, Advanced Quantum Theory and Fields, 1st Edition, S.Chand & Co., New Delhi, 1982.
5. A. Ghatak and S. Lokanathan, Quantum Mechanics: Theory and Applications, 4th Edition, Macmillan, India, 1984.

REFERENCEBOOKS

1. E. Merzbacher, Quantum Mechanics, 2nd Edition, John Wiley and Sons, New York, 1970.
2. V. K. Thankappan, Quantum Mechanics, 2nd Edition, Wiley Eastern Ltd, New Delhi, 1985.
3. L. D. Landau and E. M. Lifshitz, Quantum Mechanics, 1st edition, Pergamon Press, Oxford, 1976.
4. S. N. Biswas, Quantum Mechanics, Books and Allied Ltd., Kolkata, 1999.
5. V. Devanathan, Quantum Mechanics, 2nd edition, Alpha Science International Ltd, Oxford, 2011.

WEB SOURCES

http://research.chem.psu.edu/lxjgroup/download_files/chem565-c7.pdf
http://www.feynmanlectures.caltech.edu/III_20.html
<http://web.mit.edu/8.05/handouts/jaffe1.pdf>
https://hepwww.pp.rl.ac.uk/users/haywood/Group_Theory_Lectures/Lecture_1.pdf
<https://theory.physics.manchester.ac.uk/~xian/qm/chapter3.pdf>

COURSE OUTCOMES:

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

CO1	Demonstrates a clear understanding of the basic postulates of quantum mechanics which serve to formalize the rules of quantum Mechanics	K1, K5
CO2	Is able to apply and analyze the Schrodinger equation to solve one dimensional problems and three dimensional problems	K3, K4
CO3	Can discuss the various representations, space time symmetries and formulations of time evolution	K1
CO4	Can formulate and analyze the approximation methods for various quantum mechanical problems	K4, K5
CO5	To apply non-commutative algebra for topics such as angular and spin angular momentum and hence explain spectral line splitting.	K3, K4
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) and LOW (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) and Low (1)

Paper- 6 - PRACTICAL II	I YEAR - SECOND SEMESTER
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Subject Code	Subject Name	Category	L	T	P	Credits	Inst. Hours	Marks
23PHYP203	PRACTICAL II	Core			6	4	6	75

Pre-Requisites
Knowledge and handling of basic general and electronics experiments of Physics
Learning Objectives
➤ To understand the concept of mechanical behavior of materials and calculation of same using appropriate equations. ➤ To calculate the thermodynamic quantities and physical properties of materials. ➤ To analyze the optical and electrical properties of materials. ➤ To observe the applications of FET and UJT. ➤ To study the different applications of operational amplifier circuits. ➤ To learn about Combinational Logic Circuits and Sequential Logic Circuits

Course Details

(Any Twelve Experiments)

1. Determination of Young's modulus and Poisson's ratio by Elliptical fringes - Cornu's Method.
2. Measurement of Susceptibility of liquid - Quincke's method
3. Measurement of Magnetic Susceptibility - Guoy's method
4. Arc spectrum: Copper
5. Determination of Thickness of thin film. - Michelson Interferometer
6. Molecular spectra – CN bands
7. Determination of Refractive index of liquids using diode Laser/ He – Ne Laser
8. Hall Effect in Semiconductor. Determine the Hall coefficient, carrier concentration and carrier mobility
9. IC 7490 as scalar and seven segment display using IC 7447
10. Solving simultaneous equations – IC 741 / IC LM324
11. Op-Amp –Active filters: Low pass, High pass and Band pass filters (Second Order) Butterworth filter.
12. Construction of Current to Voltage and Voltage to Current Conversion using IC 741.
13. Construction of square wave generator using IC 555 – Study of VCO
14. Construction of Schmidt trigger circuit using IC 555 for a given hysteresis – Application as squarer
15. Construction of pulse generator using the IC 555 – Application as frequency divider
16. Study of binary up / down counters - IC 7476 / IC 7473
17. Shift register and Ring counter and Johnson counter- IC 7476/IC 7474
18. Study of synchronous parallel 4-bit binary up/down counter using IC 7493
19. Study of asynchronous parallel 4-bit binary up/down counter using IC 7493
20. Study of Modulus Counter.

TEXT BOOKS	Practical Physics, Gupta and Kumar, Pragati Prakashan Kit Developed for doing experiments in Physics- Instruction manual, R. Srinivasan K.R Priolkar, Indian Academy of Sciences Op-Amp and linear integrated circuit, Ramakanth A Gaykwad, Eastern Economy Edition. Electronic lab manual Vol I, K A Navas, Rajath Publishing Electronic lab manual Vol II, K A Navas, PHI eastern Economy Edition
REFERENCE BOOKS	1. An advanced course in Practical Physics, D. Chattopadhyay, C.R Rakshit, New Central Book Agency Pvt. Ltd 2. Advanced Practical Physics, S.P Singh, Pragati Prakashan 3. A course on experiment with He-Ne Laser, R. S. Sirohi, John Wiley & Sons (Asia) Pvt. Ltd 4. Electronic lab manual Vol II, Kuriachan T.D, Syam Mohan, Ayodhya Publishing 5. Electronic Laboratory Primer a design approach, S. Poornachandra, B. Sasikala, Wheeler Publishing, New Delhi

COURSE OUTCOMES:

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

CO1	Understand the strength of material using Young's modulus	K2
CO2	Acquire knowledge of thermal behaviour of the materials	K1
CO3	Understand theoretical principles of magnetism through the experiments.	K2
CO4	Acquire knowledge about arc spectrum and applications of laser	K1
CO5	Improve the analytical and observation ability in Physics Experiments	K4
CO6	Conduct experiments on applications of FET and UJT	K5
CO7	Analyze various parameters related to operational amplifiers	K4
CO8	Understand the concepts involved in arithmetic and logical circuits using IC's	K2
CO9	Acquire knowledge about Combinational Logic Circuits and Sequential Logic Circuits	K3
CO10	Analyze the applications of counters and registers	K4

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) and LOW (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) and Low (1)

Paper 7 - QUANTUM MECHANICS – II	II YEAR - THIRD SEMESTER
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Subject Code	Subject Name	Category	L	T	P	Credits	Inst. Hours	Marks
23PHYC301	QUANTUM MECHANICS – II	Core	5	1		5	6	75

Pre-Requisites
Knowledge of postulates of Quantum mechanics, properties of Hermitian operators, ladder operators, degeneracy, angular momentum techniques and commutation rules
Learning Objectives
➤ Formal development of the theory and the properties of angular momenta, both orbital and spin. ➤ To familiarize the students to the crucial concepts of scattering theory such as partial wave analysis and Born approximation. ➤ Time-dependent Perturbation theory and its application to study of interaction of an atom with the electromagnetic field ➤ To give the students a firm grounding in relativistic quantum mechanics, with emphasis on Dirac equation and related concepts ➤ To introduce the concept of covariance and the use of Feynman graphs for depicting different interactions

UNITS	Course Details
UNIT 1: SCATTERING THEORY	Scattering amplitude – Cross sections – Born approximation and its validity – Scattering by a screened coulomb potential – Yukawa potential – Partial wave analysis – Scattering length and Effective range theory for S wave – Optical theorem – Transformation from centre of mass to laboratory frame.
UNIT II: PERTURBATION THEORY	Time dependent perturbation theory – Constant and harmonic perturbations – Fermi Golden rule – Transition probability Einstein's A and B Coefficients – Adiabatic approximation – Sudden approximation – Semi – classical treatment of an atom with electromagnetic radiation – Selection rules for dipole radiation.
UNIT III: RELATIVISTIC QUANTUM MECHANICS	Klein – Gordon Equation – Charge And Current Densities – Dirac Matrices – Dirac Equation – Plane Wave Solutions – Interpretation of Negative Energy States – Antiparticles – Spin of Electron – Magnetic Moment of an Electron Due To Spin
UNIT IV: DIRAC EQUATION	Covariant form of Dirac Equation – Properties of the gamma matrices – Traces – Relativistic invariance of Dirac equation – Probability Density – Current four vector – Bilinear covariant – Feynman's theory of positron (Elementary ideas only without propagation formalism)
UNIT V: CLASSICAL FIELDS AND SECOND QUANTIZATION	Classical fields – Euler Lagrange equation – Hamiltonian formulation – Noether's theorem – Quantization of real and complex scalar fields – Creation, Annihilation and Number operators – Fock states – Second Quantization of K-G field.
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. P. M. Mathews and K. Venkatesan, A Text book of Quantum Mechanics, 2nd Edition, Tata McGraw-Hill, New Delhi, 2010.
2. G. Aruldas, Quantum Mechanics, 2nd Edition, Prentice-Hall of India, New Delhi, 2009
3. L. I. Schiff, Quantum Mechanics, 3rd Edition, International Student Edition, McGraw-Hill Kogakusha, Tokyo, 1968
4. V. Devanathan, Quantum Mechanics, 1st Edition, Narosa Publishing House, New Delhi, 2005.
5. Nouredine Zettili, Quantum mechanics concepts and applications, 2nd Edition, Wiley, 2017

REFERENCE BOOKS

1. P. A. M. Dirac, The Principles of Quantum Mechanics, 4th Edition, Oxford University Press, London, 1973.
2. B. K. Agarwal & Hari Prakash, Quantum Mechanics, 7th reprint, PHI Learning Pvt. Ltd., New Delhi, 2009.
3. Deep Chandra Joshi, Quantum Electrodynamics and Particle Physics, 1st edition, I.K. International Publishing house Pvt. Ltd., 2006
4. Ghatak and S. Lokanathan, Quantum Mechanics: Theory and Applications, 4th Edition, Macmillan India, New Delhi.
5. E. Merzbacher, Quantum Mechanics, 2nd edition, John Wiley and Sons, New York, 1970

WEB SOURCES

1. [https://ocw.mit.edu/courses/physics/8-05-quantum-physics-ii-fall-2013/lecture notes/MIT8_05F13_Chap_09.pdf](https://ocw.mit.edu/courses/physics/8-05-quantum-physics-ii-fall-2013/lecture%20notes/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>

COURSE OUTCOMES:

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

CO1	Familiarize the concept of scattering theory such as partial wave analysis and Born approximation	K1
CO2	Give a firm grounding in relativistic quantum mechanics, with emphasis on Dirac equation and related concepts	K2
CO3	Discuss the relativistic quantum mechanical equations namely, Klein- Gordon and Dirac equations and the phenomena accounted by them like electron spin and magnetic moment	K1, K4
CO4	Introduce the concept of covariance and the use of Feynman graphs for depicting different interactions	K1, K3
CO5	Demonstrate an understanding of field quantization and the explanation of the scattering matrix.	K5

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) and LOW (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) and Low (1)

Paper 8 - CONDENSED MATTER PHYSICS	II YEAR - THIRD SEMESTER
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Subject Code	Subject Name	Category	L	T	P	Credits	Inst. Hours	Marks
23PHYC302	CONDENSED MATTER PHYSICS	Core	5	1		5	6	75

Pre-Requisites
Basic knowledge of atomic physics, quantum mechanics and statistical mechanics.
Learning Objectives
➤ To describe various crystal structures, symmetry and to differentiate different types of bonding. ➤ To construct reciprocal space, understand the lattice dynamics and apply it to concept of specific heat. ➤ To critically assess various theories of electrons in solids and their impact in distinguishing solids. ➤ Outline different types of magnetic materials and explain the underlying phenomena. ➤ Elucidation of concepts of superconductivity, the underlying theories – relate to current areas of research.

UNITS	Course Details
UNIT I: CRYSTAL PHYSICS	Types of lattices - Miller indices – Symmetry elements and allowed rotations - Simple crystal structures – Atomic Packing Factor- Crystal diffraction - Bragg's law – Scattered Wave Amplitude - Reciprocal Lattice (sc, bcc, fcc). Structure and properties of liquid crystals. Diffraction Conditions - Laue equations - Brillouin zone - Structure factor - Atomic form factor - Inert gas crystals - Cohesive energy of ionic crystals - Madelung constant - Types of crystal binding (general ideas).
UNIT II: LATTICE DYNAMICS	Lattice with two atoms per primitive cell - First Brillouin zone - Group and phase velocities - Quantization of lattice vibrations - Phonon momentum - Inelastic scattering by phonons - Debye's theory of lattice heat capacity – Thermal Conductivity - Umklapp processes.
UNIT III: THEORY OF METALS AND 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 – Temperature Dependence - Mobility - Impurity conductivity – Impurity states- Hall effect - Fermi surfaces and construction - Experimental methods in Fermi surface studies - de Hass-van Alphen effect.
UNIT IV: MAGNETISM	Diamagnetism - Quantum theory of paramagnetism - Rare earth ion Hund's rule - Quenching of orbital angular momentum - Adiabatic magnetization - Quantum theory of ferromagnetism - Curie point - Exchange integral - Heisenberg's interpretation of Weiss field - Ferromagnetic domains - Blochwall - Spin waves - Quantization - Magnons - Thermal excitation of magnons- Curie temperature and susceptibility of ferrimagnets - Theory of antiferromagnetism - Neel temperature.
UNIT V: Superconductivity	Experimental facts: Occurrence - Effect of magnetic fields - Meissner effect – Critical field – Critical current - Entropy and heat capacity - Energy gap - Microwave and infrared properties - Type I and II Superconductors. Theoretical Explanation: Thermodynamics of super conducting transition - London equation - Coherence length – Isotope effect - Cooper pairs – Bardeen Cooper Schrieffer (BCS) Theory – BCS to Bose – Einstein Condensation (BEC) regime- Nature of pairing and condensation of Fermions. Single particle tunneling- Josephson tunneling - DC and AC Josephson effects - High temperature Superconductors – SQUIDS.
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	C. Kittel, 1996, <i>Introduction to Solid State Physics</i> , 7 th Edition, Wiley, New York. Rita John, Solid State Physics, Tata Mc-Graw Hill Publication. A. J. Dekker, <i>Solid State Physics</i> , Macmillan India, New Delhi. M. Ali Omar, 1974, <i>Elementary Solid State Physics – Principles and Applications</i> , Addison – Wesley H. P. Myers, 1998, <i>Introductory Solid State Physics</i> , 2 nd Edition, Viva Book, New Delhi.
REFERENCE BOOKS	J. S. Blakemore, 1974, <i>Solid state Physics</i> , 2 nd Edition, W.B. Saunders, Philadelphia. H. M. Rosenberg, 1993, <i>The Solid State</i> , 3 rd Edition, Oxford University Press, Oxford. J. M. Ziman, 1971, <i>Principles of the Theory of Solids</i> , Cambridge University Press, London. C. Ross-Innes and E. H. Rhoderick, 1976, <i>Introduction to Superconductivity</i> , Pergamon, Oxford. J. P. Srivastava, 2001, <i>Elements of Solid State Physics</i> , Prentice-Hall of India, New Delhi.
WEB SOURCES	1. http://www.physics.uiuc.edu/research/electronicstructure/389/389-cal.html 2. http://www.cmp.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/

COURSE OUTCOMES:

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

CO1	Student will be able to list out the crystal systems, symmetries allowed in a system and also the diffraction techniques to find the crystal structure	K1
CO2	Students will be able to visualize the idea of reciprocal spaces, Brillouin Zone and their extension to band theory of solids.	K1, K2
CO3	Student will be able to comprehend the heat conduction in solids	K3
CO4	Student will be able to generalize the electronic nature of solids from band theories.	K3, K4
CO5	Student can compare and contrast the various types of magnetism and conceptualize the idea of superconductivity.	K5

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) and LOW (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) and Low (1)

Paper 9 - ELECTROMAGNETIC THEORY	II YEAR - THIRD SEMESTER
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Subject Code	Subject Name	Category	L	T	P	Credits	Inst. Hours	Marks
23PHYC303	ELECTROMAGNETIC THEORY	Core	5	1		5	6	75

Pre-Requisites
Different coordinate systems, Laplace's equation, conducting & non-conducting medium, basic definitions in magnetism, propagation of electromagnetic waves, plasma

Learning Objectives
➤ To acquire knowledge about boundary conditions between two media and the technique of method of separation of variables ➤ To understand Biot – Savart's law and Ampere's circuital law ➤ To comprehend the physical ideas contained in Maxwell's equations, Coulomb & Lorentz gauges, conservation laws ➤ To assimilate the concepts of propagation, polarization, reflection and refraction of electromagnetic waves ➤ To grasp the concept of plasma as the fourth state of matter

UNITS	Course Details
UNIT I: ELECTROSTATICS	Boundary value problems and Laplace equation – Boundary conditions and uniqueness theorem – Laplace equation in three dimension – Solution in Cartesian and spherical polar coordinates – Examples of solutions for boundary value problems. Polarization and displacement vectors - Boundary conditions - Dielectric sphere in a uniform field – Molecular polarizability and electrical susceptibility– Electrostatic energy in the presence of dielectric – Multipole expansion.
UNIT II: MAGNETOSTATICS	Biot-Savart's Law - Ampere's law - Magnetic vector potential and magnetic field of a localized current distribution - Magnetic moment, force and torque on a current distribution in an external field - Magneto static energy - Magnetic induction and magnetic field in macroscopic media - Boundary conditions - Uniformly magnetized sphere.
UNIT III: MAXWELL EQUATIONS	Faraday's laws of Induction - Maxwell's displacement current - Maxwell's equations - Vector and scalar potentials - Gauge invariance - Wave equation and plane wave solution- Coulomb and Lorentz gauges - Energy and momentum of the field - Poynting's theorem - Lorentz force – Conservation laws for a system of charges and electromagnetic fields.
UNIT IV: WAVE PROPAGATION	Plane waves in non-conducting media - Linear and circular polarization, reflection and refraction at a plane interface - Waves in a conducting medium - Propagation of waves in a rectangular wave guide. Inhomogeneous wave equation and retarded potentials - Radiation from a localized source - Oscillating electric dipole.
UNIT V: ELEMENTARY PLASMA PHYSICS	The Boltzmann Equation - Simplified magneto-hydrodynamic equations - Electron plasma oscillations - The Debye shielding problem - Plasma confinement in a magnetic field - Magneto-hydrodynamic waves - Alfvén waves and magnetosonic waves.

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. D.J.Griffiths, 2002, *Introduction to Electrodynamics*, 3rd Edition, Prentice-Hall of India, New Delhi.
2. J. R. Reitz, F. J. Milford and R. W. Christy, 1986, *Foundations of Electromagnetic Theory*, 3rd edition, Narosa Publishing House, New Delhi.
3. J. D. Jackson, 1975, *Classical Electrodynamics*, Wiley Eastern Ltd. New Delhi.
4. J. A. Bittencourt, 1988, *Fundamentals of Plasma Physics*, Pergamon Press, Oxford.
5. Gupta, Kumar and Singh, *Electrodynamics*, S. Chand & Co. New Delhi

REFERENCE BOOKS

1. W. Panofsky and M. Phillips, 1962, *Classical Electricity and Magnetism*, Addison Wesley, London.
2. J. D. Kraus and D. A. Fleisch, 1999, *Electromagnetics with Applications*, 5th Edition, WCB McGraw-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 on Physics*, Vols. 2, Narosa Publishing House, New Delhi.
5. Andrew Zangwill, 2013, *Modern Electrodynamics*, Cambridge University Press, USA.

WEB SOURCES

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>

COURSE OUTCOMES:

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

CO1	Solve the differential equations using Laplace equation and to find solutions for boundary value problems	K1, K5
CO2	Use Biot-Savart's law and Ampere circuital law to find the magnetic induction & magnetic vector potential for various physical problems	K2, K3
CO3	Apply Maxwell's equations to describe how electromagnetic field behaves in different media	K3
CO4	Apply the concept of propagation of EM waves through wave guides in optical fiber communications and also in radar installations, calculate the transmission and reflection coefficients of electromagnetic waves	K3, K4
CO5	Investigate the interaction of ionized gases with self-consistent electric and magnetic fields	K5
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) and LOW (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) and Low (1)

Subject Code	Subject Name	Category	L	T	P	Credits	Inst. Hours	Marks
23PHYP304	PRACTICAL III: (MICROPROCESSOR 8085 AND MICROCONTROLLER 8051)	Core			6	4	6	75

Pre-Requisites

Fundamentals of digital principles

Learning Objectives

- To understand the theory and working of Microprocessor, Microcontroller and their applications
- To use microprocessor and Microcontroller in different applications

Course Details

**Practical III : MICROPROCESSOR 8085 AND MICROCONTROLLER 8051(ANY
TWELVE EXPERIMENTS)**

1. 8-bit addition and subtraction, multiplication and division
2. Sum of a set of N data (8-bit number), picking up the smallest and largest number in an array. Sorting in ascending and descending order
3. Code conversion (8-bit number): a) Binary to BCD b) BCD to binary
4. Addition of multi byte numbers, Factorial
5. Interfacing of LED – Binary up/down counter, BCD up/down counter and N/2N up/down counter
6. DAC 0800/ DAC 1048 interface and wave form generation (Unipolar/ Bipolar output)
7. ADC 0809 interface
8. Interfacing of DC stepper motor – Clockwise, Anti-clockwise, Angular movement and Wiper action
9. Traffic Light Controller
10. Addition, Subtraction, Multiplication and Division of 8-bit numbers.
11. Sum of a series of 8-bit numbers
12. Average of N numbers
13. Factorial of number
14. Fibonacci series of N terms
15. Multi byte Addition / Subtraction Sorting
16. g in ascending and descending order – Picking up smallest and largest number
17. DAC 0800 / 1408 interface and wave form generation
18. ADC interfacing
19. Stepper motor interfacing
20. Traffic light controller

TEXT BOOKS

1. Douglas V. Hall, Microprocessors and Interfacing programming and Hardware, Tata Mc Graw Hill Publications (2008)
2. Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin D. Mckinlay, The 8051 Microcontroller and Embedded Systems, Pearson Education (2008).
3. V. Vijayendran, 2005, Fundamentals of Microprocessor-8085, 3rd Edition S. Visvanathan Pvt, Ltd.
4. The 8085 Microprocessor, Architecture, Programming and Interfacing – K. Udaya Kumar, S. Uma Shankar, Pearson
5. Fundamentals of Microprocessors and Microcontrollers - B. Ram, Dhanpat Rai Publications

REFERENCE BOOKS

1. W. A. Tribel, Avtar Singh, -The 8086/8088 Microprocessors: Programming, Interfacing, Software, Hardware and Applications, Prentice-Hall of India, New Delhi.
2. Microprocessor and Its Application - S. Malarvizhi, Anuradha Agencies Publications
3. Microprocessor Architecture, Program And Its Application With 8085 - R.S. Gaonkar, New Age International (P) Ltd
4. Barry B. Brey, 1995, The Intel Microprocessors 8086/8088, 80186, 80286, 80386 and 80486, 3rd Edition, Prentice- Hall of India, New Delhi.
5. J. Uffrenbeck, -The 8086/8088 Family-Design, Programming and Interfacing, Software, Hardware and Applications, Prentice-Hall of India, New Delhi.

METHOD OF EVALUATION:

Continuous Internal Assessment	End Semester Examination	Total	Grade
25	75	100	

COURSE OUTCOMES:

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

CO1	Develop the programming skills of Microprocessor	K5
CO2	Appreciate the applications of Microprocessor programming	K3
CO3	Understand the structure and working of 8085 microprocessor and apply it.	K1, K3
CO4	Acquire knowledge about the interfacing peripherals with 8085 microprocessor.	K1, K4
CO5	Acquire knowledge about the interfacing 8051 microcontroller with various peripherals.	K1, K4
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) and LOW (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) and Low (1)

Subject Code	Subject Name	Category	L	T	P	Credits	Inst. Hours	Marks
23PHYC401	NUCLEAR AND PARTICLE PHYSICS	Core	5	1		5	6	75

Pre-Requisites
Knowledge of basic structure of atom and nucleus.
Learning Objectives
➤ Introduces students to the different models of the nucleus in a chronological order ➤ Imparts an in-depth knowledge on the nuclear force, experiments to study it and the types of nuclear reactions and their principles ➤ Provides students with details of nuclear decay with relevant theories ➤ Exposes students to the Standard Model of Elementary Particles and Higgs boson

UNITS	Course Details
UNIT I: NUCLEAR MODELS	Liquid drop model – Weizacker mass formula – Isobaric mass parabola – Mirror Pair - Bohr Wheeler theory of fission – shell model – spin-orbit coupling – magic numbers – angular momenta and parity of ground states – magnetic moment – Schmidt model – electric Quadrupole moment - Bohr and Mottelson collective model – rotational and vibrational bands.
UNIT II: NUCLEAR FORCES	Nucleon – nucleon interaction – Tensor forces – properties of nuclear forces – ground state of deuteron – Exchange Forces - Meson theory of nuclear forces – Yukawa potential – nucleon-nucleon scattering – effective range theory – spin dependence of nuclear forces - charge independence and charge symmetry – isospin formalism.
UNIT III: NUCLEAR REACTIONS	Kinds of nuclear reactions – Reaction kinematics – Q-value – Partial wave analysis of scattering and reaction cross section – scattering length – Compound nuclear reactions – Reciprocity theorem – Resonances – Breit Wigner one level formula – Direct reactions - Nuclear Chain reaction – four factor formula.
UNIT IV: NUCLEAR DECAY	Beta decay – Continuous Beta spectrum – Fermi theory of beta decay - Comparative Half-life – Fermi Kurie Plot – mass of neutrino – allowed and forbidden decay — neutrino physics – Helicity - Parity violation - Gamma decay – multipole radiations – Angular Correlation - internal conversion – nuclear isomerism – angular momentum and parity selection rules.
UNIT V: ELEMENTARY PARTICLES	Classification of Elementary Particles – Types of Interaction and conservation laws – Families of elementary particles – Isospin – Quantum Numbers – Strangeness – Hypercharge and Quarks – SU (2) and SU (3) groups- Gell Mann matrices– Gell Mann Okuba Mass formula-Quark Model. Standard model of particle physics – Higgs boson.
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	D. C. Tayal – Nuclear Physics – Himalaya Publishing House (2011) K. S. Krane – Introductory Nuclear Physics – John Wiley & Sons (2008) R. Roy and P. Nigam – Nuclear Physics – New Age Publishers (1996) S. B. Patel – Nuclear Physics – An introduction – New Age International Pvt Ltd Publishers (2011) S. Glasstone – Source Book of Atomic Energy – Van Nostrand Reinhold Inc., U.S.- 3rd Revised edition (1968)
REFERENCE BOOKS	1. L. J. Tassie – The Physics of elementary particles – Prentice Hall Press (1973) 2. H. A. Enge – Introduction to Nuclear Physics – Addison Wesley, Publishing Company. Inc. Reading. New York, (1974). 3. Kaplan – Nuclear Physics – 1989 – 2nd Ed. – Narosa (2002) 4. Bernard L Cohen – Concepts of Nuclear Physics – McGraw Hill Education (India) Private Limited; 1 edition (2001) 5. B.L. Cohen, 1971, Concepts of Nuclear Physics, TMCH, New Delhi.
WEB SOURCES	1. http://bubl.ac.uk/link/n/nuclearphysics.html 2. http://www.phys.unsw.edu.au/PHYS3050/pdf/Nuclear_Models.pdf http://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

COURSE OUTCOMES:

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

CO1	Gain knowledge about the concepts of helicity, parity, angular correlation and internal conversion.	K1, K5
CO2	Demonstrate knowledge of fundamental aspects of the structure of the nucleus, radioactive decay, nuclear reactions and the interaction of radiation and matter.	K2, K3
CO3	Use the different nuclear models to explain different nuclear phenomena and the concept of resonances through Breit-Weigner single level formula	K3
CO4	Analyze data from nuclear scattering experiments to identify different properties of the nuclear force.	K3, K4
CO5	Summarize and identify allowed and forbidden nuclear reactions based on conservation laws of the elementary particles.	K5
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) and LOW (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) and Low (1)

Subject Code	Subject Name	Category	L	T	P	Credits	Inst. Hours	Marks
23PHYC402	SPECTROSCOPY	Core	5	1		5	6	75

Pre-Requisites

Thorough understanding of electromagnetic spectrum, mathematical abilities, knowledge of molecules, their structure, bond nature, physical and chemical behaviour

Learning Objectives

- To comprehend the theory behind different spectroscopic methods
- To know the working principles along with an overview of construction of different types of spectrometers involved
- To explore various applications of these techniques in R &D.
- Apply spectroscopic techniques for the qualitative and quantitative analysis of various chemical compounds.
- Understand this important analytical tool

UNITS	Course Details
UNIT I: MICROWAVE SPECTROSCOPY	Rotational spectra of diatomic molecules - Rigid Rotor (Diatomic Molecules)- reduced mass – rotational constant - Effect of isotopic substitution - Non rigid rotator – centrifugal distortion constant- Intensity of Spectral Lines- Polyatomic molecules – linear – symmetric asymmetric top molecules - Hyperfine structure and quadrupole moment of linear molecules - Instrumentation techniques –block diagram -Information Derived from Rotational Spectra- Stark effect- Problems.
UNIT II: INFRARED SPECTROSCOPY	Vibrations of simple harmonic oscillator – zero-point energy- Anharmonic oscillator – fundamentals, overtones and combinations- Diatomic Vibrating Rotator- PR branch – PQR branch- Fundamental modes of vibration of H ₂ O and CO ₂ -Introduction to application of vibrational spectra- IR Spectrophotometer Instrumentation (Double Beam Spectrometer) – Fourier Transform Infrared Spectroscopy - Interpretation of vibrational spectra– remote analysis of atmospheric gases like N ₂ O using FTIR by National Remote Sensing Centre(NRSC), India– other simple applications.
UNIT III: RAMAN SPECTROSCOPY	Theory of Raman Scattering - Classical theory – molecular polarizability –polarizability ellipsoid - Quantum theory of Raman effect - rotational Raman spectra of linear molecule - symmetric top molecule – Stokes and anti-stokes line- SR branch -Raman activity of H ₂ O and CO ₂ .Mutual exclusion principle- determination of N ₂ O structure -Instrumentation technique and block diagram - structure determination of planar and non-planar molecules using IR and Raman techniques - FT Raman spectroscopy- SERS.
UNIT IV: RESONANCE SPECTROSCOPY	Nuclear and Electron spin-Interaction with magnetic field - Population of Energy levels - Larmor precession- Relaxation times - Double resonance- Chemical shift and its measurement - NMR of Hydrogen nuclei - Indirect Spin - Spin Interaction – interpretation of simple organic molecules -Instrumentation techniques of NMR spectroscopy – NMR in Chemical industries- MRI Scan Electron Spin Resonance: Basic principle –Total Hamiltonian (Direct Dipole- Dipole interaction and Fermi Contact Interaction) – Hyperfine Structure (Hydrogen atom) – ESR Spectra of Free radicals –g-factors – Instrumentation - Medical applications of ESR
UNIT V: UV SPECTROSCOPY	Origin of UV spectra - Laws of absorption – Lambert Bouguer law – Lambert Beer law - molar absorptivity – transmittance and absorbance - Color in organic compounds- Absorption by organic Molecule -Chromophores - Effect of conjugation on chromophores - Choice of Solvent and Solvent effect - Absorption by inorganic systems - Instrumentation - double beam UV- Spectrophotometer -Simple applications.

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. C.N. Banwell and E M McCash, 1994, Fundamentals of Molecular Spectroscopy, 4th Edition, Tata McGraw-Hill, New Delhi.
2. G. Aruldhas, 1994, Molecular Structure and Molecular Spectroscopy, Prentice-Hall of India, New Delhi.
3. D.N. Satyanarayana, 2001, *Vibrational Spectroscopy and Applications*, New Age International Publication.
4. B.K. Sharma, 2015, *Spectroscopy*, Goel Publishing House Meerut.
5. Kalsi. P.S, 2016, Spectroscopy of Organic Compounds (7th Edition), New Age International Publishers.

REFERENCE BOOKS

1. J L McHale, 2008, Molecular Spectroscopy, Pearson Education India, New Delhi.
2. J M Hollas, 2002, Basic Atomic and Molecular Spectroscopy, Royal Society of Chemistry, RSC, Cambridge.
3. B. P. Straughan and S. Walker, 1976, Spectroscopy Vol. I, Chapman and Hall, New York.
4. K. Chandra, 1989, Introductory Quantum Chemistry, Tata McGraw Hill, New Delhi.
5. Demtroder. W, Laser Spectroscopy: Basic concepts and Instrumentation, Springer Link.

WEB SOURCES

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>

COURSE OUTCOMES:

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

CO1	Understand fundamentals of rotational spectroscopy, view molecules as elastic rotors and interpret their behaviour. Able to quantify their nature and correlate them with their characteristic properties.	K2
CO2	Understand the working principles of spectroscopic instruments and theoretical background of IR spectroscopy. Able to correlate mathematical process of Fourier transformations with instrumentation. Able to interpret vibrational spectrum of small molecules.	K2, K3
CO3	Interpret structures and composition of molecules and use their knowledge of Raman Spectroscopy as an important analytical tool	K5
CO4	Use these resonance spectroscopic techniques for quantitative and qualitative estimation of substances	K4
CO5	Learn the electronic transitions caused by absorption of radiation in the UV/Vis region of the electromagnetic spectrum and be able to analyze a simple UV spectrum.	K1, K5
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) and LOW (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) and Low (1)

DEPARTMENT ELECTIVE COURSES

Elective – 1 . MATERIALS SCIENCE	I YEAR - FIRST SEMESTER
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Subject Code	Subject Name	Category	L	T	P	Credits	Inst. Hours	Marks
23PHYE104	MATERIALS SCIENCE	ELECTIVE	4	1		3	5	75

Pre-Requisites
Basic knowledge on different types of materials
Learning Objectives
➤ To gain knowledge on optoelectronic materials ➤ To learn about ceramic processing and advanced ceramics ➤ To understand the processing and applications of polymeric materials ➤ To gain knowledge on the fabrication of composite materials ➤ To learn about shape memory alloys, metallic glasses and nanomaterials

UNITS	Course details
UNIT I: OPTOELECTRONIC MATERIALS	Importance of optical materials – properties: Band gap and lattice matching – optical absorption and emission – charge injection, quasi- Fermi levels and recombination – optical absorption, loss and gain. Optical processes in quantum structures: Inter-band and intra-band transitions Organic semiconductors. Light propagation in materials – Electro-optic effect and modulation, electro-absorption modulation – exciton quenching.
UNIT II CERAMIC MATERIALS	Ceramic processing: powder processing, milling and sintering – structural ceramics: zirconia, alumina, silicon carbide, tungsten carbide – electronic ceramics – refractories – glass and glass ceramics
UNIT III POLYMERIC MATERIALS	Polymers and copolymers – molecular weight measurement – synthesis: chain growth polymerization – polymerization techniques – glass transition temperature and its measurement – viscoelasticity – polymer processing techniques – applications: conducting polymers, biopolymers and high temperature polymers.
UNIT IV COMPOSITE MATERIALS	Particle reinforced composites – fiber reinforced composites – mechanical behavior – fabrication methods of polymer matrix composites and metal matrix composites – carbon/carbon composites: fabrication and applications.
UNIT V: NEW MATERIALS	Shape memory alloys: mechanisms of one-way and two-way shape memory effect, reverse transformation, thermo-elasticity and pseudo- elasticity, examples and applications -bulk metallic glass: criteria for glass formation and stability, examples and mechanical behavior - nanomaterials: classification, size effect on structural and functional properties, processing and properties of Nano crystalline materials, single walled and multi walled carbon nanotubes
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. Jasprit Singh, Electronic and optoelectronic properties 2. P. K. Mallick. Fiber-Reinforced Composites. CRC Press, 2008. 3. V. Raghavan, 2003, Materials Science and Engineering, 4 th Edition, Prentice- Hall India, New Delhi (For units 2,3,4 and 5) 4. G.K. Narula, K.S. Narula and V.K. Gupta, 1988, Materials Science, Tata McGraw-Hill 5. M. Arumugam, 2002, Materials Science, 3 rd revised Edition, Anuratha Agencies
REFERENCE BOOKS	1. B. S. Murty, P. Shankar, B. Raj, B. B. Rath and J. Murday. Textbook of Nanoscience and Nanotechnology. Springer- Verlag, 2012. 2. K. Yamauchi, I. Ohkata, K. Tsuchiya and S. Miyazaki (Eds). Shape Memory and Super Elastic Alloys: Technologies and Applications. Wood head Publishing Limited, 2011. 3. Lawrence H. Van Vlack, 1998. Elements of Materials Science and Engineering, 6 th Edition, Second ISE reprint, Addison-Wesley. 4. H. Ibach and H. Luth, 2002, Solid State Physics – An Introduction to Principles of Materials Science, 2 nd Edition, Springer. 5. D. Hull & T. W. Clyne, An introduction to composite materials, Cambridge University Press, 2008.
WEB SOURCES	1. https://onlinecourses.nptel.ac.in/noc20_mm02/preview 2. https://nptel.ac.in/courses/112104229 3. https://archive.nptel.ac.in/courses/113/105/1131050814 . https://nptel.ac.in/courses/113/105/113105025/ https://eng.libretexts.org/Bookshelves/Materials_Science/Supplemental_Modules_(Materials_Science)/Electronic_Properties/Lattice_Vibrations

COURSE OUTCOMES:

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

CO1	Acquire knowledge on optoelectronic materials	K1
CO2	Be able to prepare ceramic materials	K3
CO3	Be able to understand the processing and applications of polymeric materials	K2, K3
CO4	Be aware of the fabrication of composite materials	K5
CO5	Be knowledgeable of shape memory alloys, metallic glasses and nanomaterials	K1

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) and LOW (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) and Low (1)

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

Pre-Requisites

Exposure to Fourier transform, pulse modulation, multiplexing, noises in communication signals

Learning Objectives

- To understand the use of Fourier, transform in analyzing the signals
- To learn about the quanta of transmission of information
- To make students familiar with different types of pulse modulation
- To have an in depth knowledge about the various methods of error controlling codes
- To acquire knowledge about spread spectrum techniques in getting secured communication

UNITS	Course Details
UNIT I: SIGNAL ANALYSIS	Fourier transforms of gate functions, delta functions at the origin – Two delta function and periodic delta function – Properties of Fourier transform – Frequency shifting –Time shifting - Convolution –Graphical representation – Convolution theorem – Time Convolution theorem – Frequency Convolution theorem –Sampling theorem.
UNIT II: INFORMATION THEORY	Communication system – Measurement of information – Coding – Bandot Code CCITT Code –Hartley Law – Noise in an information Carrying Channel- Effects of noise- Capacity of noise in a channel – ShannonHartley theorem –Redundancy.
UNIT III: PULSE MODULATION	Pulse amplitude modulation - natural sampling – Instantaneous sampling - Transmission of PAM Signals -Pulse width modulation – Time division multiplexing – Band width requirements for PAM Signals. Pulse Code Modulation –Principles of PCM –Quantizing noise – Generation and demodulation of PCM -Effects of noise –Companding – Advantages and application
UNIT IV: ERROR CONTROL CODING	Introduction to Linear Block Codes, Hamming Codes, BCH Coding, RSCoding, Convolutional Coding, Coding Grain Viterbi Coding
UNIT V: SPREAD SPECTRUM SYSTEMS	Pseudo Noise sequences, generation and Correlation properties, direct sequence spread spectrum systems, frequency HOP Systems, processing gain, anti-jam and multipath performance
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	B.P. Lathi, <i>Communication system</i>, Wiley Eastern. George Kennedy, <i>Electronic Communication Systems</i>, 3rd Edition, McGraw Hill. Simon Haykin, <i>Communication System</i>, 3rd Edition, John Wiley & Sons. George Kennedy and Davis, 1988, <i>Electronic Communication System</i>, Tata McGraw Hill 4th Edition. Taub and Schilling, 1991, <i>“Principles of Communication System”</i>, Second edition Tata McGraw Hill.
REFERENCE BOOKS	John Proakis, 1995, <i>Digital Communication</i>, 3rd Edition, McGraw Hill, Malaysia. M. K. Simen, 1999, <i>Digital Communication Techniques, Signal Design and Detection</i>, Prentice Hall of India. Dennis Roddy and Coolen, 1995, <i>Electronics communications</i>, Prentice Hall of India IV Edition. Wave Tomasi, 1998, <i>“Advanced Electronics communication System”</i> 4th Edition Prentice Hall, Inc. M.Kulkarni, 1988, <i>“Microwave and Radar Engineering”</i>, Umesh Publications.
WEB SOURCES	http://nptel.iitm.ac.in/ http://web.ewu.edu/ http://www.ece.umd.edu/class/enee630.F2012.html http://www.atcourses.com/Advanced%20Topics%20in%20Digital%20Signals http://nptel.iitm.ac.in/courses/117101051.html

COURSE OUTCOMES:

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

CO1	Apply the techniques of Fourier transform, convolution and sampling theorems in signal processing	K1, K3
CO2	Apply different information theories in the process of study of coding of information, storage and communication	K3
CO3	Explain and compare the various methods of pulse modulation techniques	K4
CO4	Apply the error control coding techniques in detecting and correcting errors-able to discuss, analyze and compare the different error control coding	K3, K4
CO5	Apply, discuss and compare the spread spectrum techniques for secure communications	K3, k5
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) and LOW (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) and Low (1)

Elective – 3. COMMUNICATION ELECTRONICS	I YEAR - FIRST SEMESTER
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Subject Code	Subject Name	Category	L	T	P	Credits	Inst. Hours	Marks
23PHYE104	COMMUNICATIONELECTRONICS	ELECTIVE	4	1		3	5	75

Pre-Requisites
Knowledge of Regions of electromagnetic spectrum and its characteristics

Learning Objectives
➤ To comprehend the transmission of electromagnetic waves thorough different types of antenna and also to acquire knowledge about the propagation of waves through earth's atmosphere and along the surface of the earth ➤ To gain knowledge in the generation and propagation of microwaves ➤ To acquire knowledge about radar systems and its applications and also the working principle of colour television ➤ To learn the working principle of fiber optics and its use in telecommunication ➤ To understand the general theory and operation of satellite communication systems

UNITS	Course Details
UNIT I: ANTENNAS AND WAVE PROPAGATION	Radiation field and radiation resistance of short dipole antenna - grounded antenna - ungrounded antenna - antenna arrays - broadside and end side arrays - antenna gain - directional high frequency antennas - sky wave - ionosphere - Eccles and Larmor theory - Magneto ionic theory - ground wave propagation.
UNIT II: MICROWAVES	Microwave generation - multi cavity Klystron-reflex klystron- magnetron travelling wave tubes (TWT) and other microwave tubes- MASER-Gunn diode-wave guides-rectangular wave guides-standing wave indicator and standing wave ratio (SWR)
UNIT III: RADAR AND TELEVISION	Elements of a radar system-radar equation-radar performance Factors radar transmitting systems-radar antennas-duplexers-radar receivers and indicators-pulsed systems- other radar systems- colour TV transmission and reception-colour mixing principle-colour picture tubes- Delta gun picture tube-PIL colour picture tube-cable TV, CCTV and theatre TV
UNIT IV: OPTICAL FIBER	Propagation of light in an optical fibre-acceptance angle-numerical aperture-step and graded index fibres-optical fibres as a cylindrical wave guide-wave guide equations-wave guide equations in step index fibres - fibre losses and dispersion-applications
UNIT V: SATELLITE COMMUNICATION	Orbital satellites-geostationary satellites-orbital patterns-satellite system link models-satellite system parameters-satellite system link equation link budget-INSAT communication satellites
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. Handbook of Electronics by Gupta and Kumar, 2008 edition.
2. Electronic communication systems – George Kennedy and Davis, Tata McGraw Hill, 4th edition, 1988.
3. Taub and Schilling, principles of communication systems, second edition, Tata McGraw Hill (1991).
4. M. Kulkarani, Microwave and radar engineering, Umesh Publications, 1998.
5. Mono Chrome and colour television, R. R. Ghulathi

REFERENCE BOOKS

1. Electronic communications – Dennis Roddy and Coolen, Prentice Hall of India, IV edition, 1995.
2. Wayne Tomasi, Advanced electronics communication systems, fourth edition, Prentice Hall of India, 1998
3. Dennis Roddy and Coolen, 1995, *Electronics communications*, Prentice Hall of India IV Edition.
4. Wayne Tomasi, 1998 “*Advanced Electronics communication System*” 4th edition, Prentice Hall of India, 1998
5. S. Salivahanan, N. Suresh Kumar & A. Vallavaraj, 2009, *Electronic Devices and Circuits*, Tata McGraw-Hill Publishing Company Limited, New Delhi, Second Edition.

WEB SOURCES

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/>

COURSE OUTCOMES:

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

CO1	Discuss and compare the propagation of electromagnetic waves through sky and on earth's surface Evaluate the energy and power radiated by the different types of antenna	K1, K5
CO2	Compare and differentiate the methods of generation of microwaves analyze the propagation of microwaves through wave guides- discuss and compare the different methods of generation of microwaves	K4
CO3	Classify and compare the working of different radar systems- apply the principle of radar in detecting locating, tracking, and recognizing objects of various kinds at considerable distances – discuss the importance of radar in military- elaborate and compare the working of different picture tube	K3
CO4	Classify, discuss and compare the different types of optical fiber and also to justify the need of it-discover the use of optical fiber as wave guide	K1, K3
CO5	Explain the importance of satellite communication in our daily life-distinguish between orbital and geostationary satellites elaborate the linking of satellites with ground station on the earth	K4
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) and LOW (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) and Low (1)

Elective– 4. ENERGY PHYSICS	I YEAR - FIRST SEMESTER
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SubjectCode	Subject Name	Category	L	T	P	Credits	Inst. Hours	Marks
23PHYE105	ENERGYPHYSICS	ELECTIVE	4	1		3	5	75

Pre-Requisites
Knowledge of conventional energy resources
Learning Objectives
➤ To learn about various renewable energy sources. ➤ To know the ways of effectively utilizing the oceanic energy. ➤ To study the method of harnessing wind energy and its advantages. ➤ To learn the techniques useful for the conversion of biomass into useful energy. ➤ To know about utilization of solar energy.

UNITS	Course Details
UNIT I: INTRODUCTION TO ENERGY SOURCES	Conventional and non-conventional energy sources and their availability–prospects of Renewable energy sources– Energy from other sources– chemical energy–Nuclear energy– Energy storage and distribution.
UNIT II: ENERGY FROM THE OCEANS	Energy utilization–Energy from tides–Basic principle of tidal power–utilization of tidal energy – Principle of ocean thermal energy conversion systems.
UNIT III: WIND ENERGY SOURCES	Basic principles of wind energy conversion–power in the wind–forces in the Blades– Wind energy conversion–Advantages and disadvantages of wind energy conversion systems (WECS) - Energy storage–Applicationsof wind energy.
UNIT IV: ENERGY FROM BIOMASS	Biomass conversion Technologies– wet and dry process– Photosynthesis -Biogas Generation: Introduction–basic process: Aerobic and anaerobic digestion – Advantages of anaerobic digestion–factors affecting bio digestion and generation of gas- bio gas from waste fuel– properties of biogas-utilization of biogas.
UNIT V: SOLAR ENERGY SOURCES	Solar radiation and its measurements–solar cells: Solar cells for direct conversion of solar energy to electric powers–solar cell parameter–solar cell electrical characteristics– Efficiency–solar water Heater –solar distillation– solar cooking–solar greenhouse – Solar pond and its applications.
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. G.D. Rai, 1996, Non – convention sources of, 4th edition, Khanna publishers, New Delhi. 2. S. Rao and Dr. Paru Lekar, Energy technology. 3. M.P. Agarwal, Solar Energy, S. Chand and Co., New Delhi (1983). 4. Solar energy, principles of thermal collection and storage by S. P. Sukhatme, 2 nd edition, Tata McGraw-Hill Publishing Co. Lt., New Delhi (1997). 5. Energy Technology by S. Rao and Dr. Parulekar.
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REFERENCE BOOKS	1. Renewable energy resources, John Twidell and Tonyweir, Taylor andFrancis group, London and New York. 2. Applied solar energy, A. B. Meinel and A. P. Meinal 3. John Twidell and Tony Weir, Renewable energy resources, Taylor andFrancis group, London and New York. 4. Renewal Energy Technologies: A Practical Guide for Beginners C.S.Solanki-PHI Learning 5. Introduction to Non-Conventional Energy Resources -Raja et. al., Sci. Tech Publications
WEB SOURCES	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:

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

CO1	To identify various forms of renewable and non-renewable energy sources	K1
CO2	Understand the principle of utilizing the oceanic energy and apply it for practical applications.	K2
CO3	Discuss the working of a windmill and analyze the advantages of wind energy.	K3
CO4	Distinguish aerobic digestion process from anaerobic digestion.	K3, K4
CO5	Understand the components of solar radiation, their measurement and apply them to utilize solar energy.	K2, K5

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) and LOW(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) and Low (1)

Elective – 5. BIO PHYSICS	I YEAR - FIRST SEMESTER
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Subject Code	Subject Name	Category	L	T	P	Credits	Inst. Hours	Marks
23PHYE105	BIO PHYSICS	ELECTIVE	4	1		3	5	75

Pre-Requisites
Fundamental concepts of Physics and Biology
Learning Objectives
➤ To understand the physical principles involved in cell function maintenance. ➤ To understand the fundamentals of macromolecular structures involved in propagation of life. ➤ To understand the biophysical function of membrane and neuron. ➤ To understand various kinds of radiation and their effects on living system and to know the hazards posed by such radiations and the required precautions. ➤ To understand the physical principles behind the various techniques available for Interrogating biological macromolecules.

UNITS	Course Details
UNIT I: CELLULAR BIOPHYSICS	Architecture and Life Cycle of cells – Organelles of Prokaryotic and Eukaryotic cell – Cell size and shape – Fine structure of Prokaryotic and Eukaryotic cell organization – Compartment & assemblies membrane system – Extracellular matrix - Molecular mechanisms of Vesicular traffic - Electrical activities of cardiac and neuronal cells.
UNIT II: MOLECULAR BIOPHYSICS	Macromolecular structure: Protein structure – amino acids, peptide bonds, primary, secondary, tertiary and quaternary structures of proteins Nucleic acid structure: nucleosides and nucleotides, RNA structure, DNA structure and conformation. Special Bio-macromolecules: Metalloproteins, nucleoproteins, ribozymes, chaperons and prions.
UNIT III: MEMBRANE AND NEURO BIOPHYSICS	Models membranes - Biological membranes and dynamics – Membrane Capacitors – Transport across cell and organelle membranes – Ion channels. Nervous system: Organization of the nervous system – Membrane potential – Origins of membrane potential - Electrochemical potentials – Nernst equation – Goldman equation.
UNIT IV: RADIATION BIOPHYSICS	X-Ray: Effects on bio-macromolecules – Gamma Radiation: Molecular effects of gamma radiation, Radiation effects on nucleic acids and membranes, Effects on cell and organelles – UV radiation: Effects on bio-macromolecules and proteins – Radiation hazards and protection – use of radiations in cancer.

UNIT V: PHYSICAL METHODS IN BIOLOGY	Spectroscopy: UV-Visible absorption spectrophotometry – Optical Rotatory Dispersion (ORD) – Structure Determination: X-ray Crystallography, Electron spin resonance (ESR) and biological applications. Chromatography: Thin layer chromatography (TLC), Gas liquid chromatography (GLC) – Centrifugation: Differential centrifugation, density gradient centrifugation. Electrophoresis: Gel electrophoresis, polyacrylamide gel electrophoresis.
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. The cell: A molecular approach, Geoffrey M. Cooper, ASM Press, 2013. 2. Biophysics, Vasantha Patabhi, N. Gautham, Narosa Publishing, 2009 3. Biophysics, P. S. Mishra VK Enterprises, 2010. 4. Biophysics, M. A Subramanian, MJP Publishers, 2005. 5. Bioinstrumentation, L. Veerakumari, MJP Publishers, 2006.
REFERENCE BOOKS	1. Chemical Biophysics by Daniel A Beard (Cambridge University Press, 2008). 2. Essential cell biology by Bruce Albert et al (Garland Science) 3. Biophysics, W. Hoppe, W. Lohmann, H. Markl and H. Ziegler. Springer Verlag, Berlin (1983). 4. Membrane Biophysics by Mohammad Ashrafuzzaman, Jack A. Tuszynski, (Springer science & business media). 5. Biological spectroscopy by Iain D. Campbell, Raymond A. Dwek
WEB SOURCES	1. General Bio: 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. Online biophysics programs: http://mw.concord.org/modeler/ 5. https://blanco.biomol.uci.edu/WWWResources.html

COURSE OUTCOMES:

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

CO1	Understand the structural organization and function of living cells and shouldable to apply the cell signaling mechanism and its electrical activities.	K2, K3
CO2	Comprehension of the role of biomolecular conformation to function.	K1
CO3	Conceptual understanding of the function of biological membranes and also to understand the functioning of nervous system.	K2, K5
CO4	To know the effects of various radiations on living systems and how to preventill effects of radiations.	K1, K5
CO5	Analyze and interpret data from various techniques viz., spectroscopy, crystallography, chromatography etc.,	K4
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) and LOW (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) and Low (1)

Elective – 6. CRYSTAL GROWTH AND THINFILMS	I YEAR - FIRST SEMESTER
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Subject Code	Subject Name	Category	L	T	P	Credits	Inst. Hours	Marks
23PHYE105	CRYSTAL GROWTH AND THIN FILMS	ELECTIVE	4	1		3	5	75

Pre-Requisites
Fundamentals of Crystal Physics
Learning Objectives
➤ To acquire the knowledge on Nucleation and Kinetics of crystal growth ➤ To understand the Crystallization Principles and Growth techniques ➤ To study various methods of Crystal growth techniques ➤ To understand the thin film deposition methods ➤ To apply the techniques of Thin Film Formation and thickness Measurement

UNITS	Course Details
UNIT I: CRYSTAL GROWTH KINETICS	Basic Concepts, Nucleation and Kinetics of growth Ambient phase equilibrium - super saturation - equilibrium of finite phases equation of Thomson - Gibbs - Types of Nucleation - Formation of critical Nucleus - Classical theory of Nucleation - Homo and heterogeneous formation of 3D nuclei - rate of Nucleation - Growth from vapour phase solutions, solutions and melts - epitaxial growth - Growth mechanism and classification - Kinetics of growth of epitaxial films
UNIT II: CRYSTALLIZATION PRINCIPLES	Crystallization Principles and Growth techniques Classes of Crystal system - Crystal symmetry - Solvents and solutions - Solubility diagram - Super solubility - expression for super saturation - Metastable zone and introduction period - Miers TC diagram – Solution growth - Low and high temperatures solution growth - Slow cooling and solvent evaporation methods - Constant temperature bath as a Crystallizer.
UNIT III: GEL, MELT AND VAPOUR GROWTH	Gel, Melt and Vapour growth techniques Principle of Gel techniques - Various types of Gel - Structure and importance of Gel - Methods of Gel growth and advantages - Melt techniques - Czochralski growth - Floating zone - Bridgman method - Horizontal gradient freeze - Flux growth - Hydrothermal growth - Vapour phase growth – Physical vapour deposition - Chemical vapour deposition - Stoichiometry.
UNIT IV: THIN FILM DEPOSITION METHODS	Thin film deposition methods of thin film preparation, Thermal evaporation, Electron beam evaporation, pulsed LASER deposition, Cathodic sputtering, RF Magnetron sputtering, MBE, chemical vapour deposition methods, Sol Gel spin coating, Spray pyrolysis, Chemical bath deposition.
UNIT V: THIN FILM FORMATION	Thin Film Formation and thickness Measurement Nucleation, Film growth and structure - Various stages in Thin Film formation, Thermodynamics of Nucleation, Nucleation theories, Capillarity model and Atomistic model and their comparison. Structure of Thin Film, Roll of substrate, Roll of film thickness, Film thickness measurement - Interferometry, Ellipsometry, Micro balance, Quartz Crystal Oscillator techniques.

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. Markov Crystal growth for beginners: Fundamentals of Nucleation, Crystal Growth and Epitaxy (2004) 2nd edition 2. A. Goswami, Thin Film Fundamentals (New Age, New Delhi, 2008) 3. M. Ohora and R. C. Reid, -Modeling of Crystal Growth Rates from Solution 4. D. Elwell and H. J. Scheel, -Crystal Growth from High Temperature Solution 5. Heinz K. Henish, 1973, -Crystal Growth in Gels, Cambridge University Press. USA
REFERENCE BOOKS	1. J.C. Brice, Crystal Growth Process (John Wiley, New York, 1986) 2. P. Ramasamy and F. D. Gnanam, 1983, -UGC Summer School Notes. 3. P. Santhana Raghavan and P. Ramasamy, -Crystal Growth Processes, KRU Publications. 4. H.E. Buckley, 1951, Crystal Growth, John Wiley and Sons, New York 5. B.R. Pamplin, 1980, Crystal Growth, Pergman Press, London.
WEB SOURCES	1. https://www.youtube.com/playlist?list=PLbMVogVj5nJRjLrXp3kMtrIO8kZl1D1Jp 2. https://www.youtube.com/playlist?list=PLFW6lRTa1g83HGEihgwy7KeTLUuBu3WF 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/

COURSE OUTCOMES:

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

CO1	Acquire the Basic Concepts, Nucleation and Kinetics of crystal growth	K1
CO2	Understand the Crystallization Principles and Growth techniques	K2, K4
CO3	Study various methods of Crystal growth techniques	K3
CO4	Understand the Thin film deposition methods	K2
CO5	Apply the techniques of Thin Film Formation and thickness Measurement	K3, K4
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) and LOW (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) and Low (1)

Elective – 7. ADVANCED OPTICS	I YEAR – SECOND SEMESTER
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Subject Code	Subject Name	Category	L	T	P	Credits	Inst. Hours	Marks
23PHYE204	ADVANCED OPTICS	ELECTIVE	4			3	4	75

Pre-Requisites
Knowledge of ray properties and wave nature of light
Learning Objectives
➤ To know the concepts behind polarization and could pursue research work on application aspects of laser ➤ To impart an extensive understanding of fiber and non-linear optics ➤ To study the working of different types of LASERS ➤ To differentiate first and second harmonic generation ➤ Learn the principles of magneto-optic and electro-optic effects and its applications

UNITS	Course Details
UNIT 1: POLARIZATION AND DOUBLE REFRACTION	Classification of polarization – Transverse character of light waves –Polarizer and analyzer – Malu's law – Production of polarized light – Wire grid polarizer and the polaroid – Polarization by reflection – Polarization by double refraction – Polarization by scattering – The phenomenon of double refraction – Normal and oblique incidence – Interference of polarized light: Quarter and half wave plates – Analysis of polarized light – Optical activity
UNIT II: LASERS	Basic principles – Spontaneous and stimulated emissions – Components of the laser – Resonator and lasing action – Types of lasers and its applications – Solid state lasers – Ruby laser – Nd:YAG laser – gas lasers – He-Ne laser – CO ₂ laser – Chemical lasers – HCl laser – Semiconductor laser
UNIT III: FIBER OPTICS	Introduction – Total internal reflection – The optical fiber – Glass fibers – The coherent bundle – The numerical aperture – Attenuation in optical fibers – Single and multi-mode fibers – Pulse dispersion in multimode optical fibers – Ray dispersion in multimode step index fibers – Parabolic-index fibers – Fiber-optic sensors: precision displacement sensor – Precision vibration sensor
UNIT IV: NON-LINEAR OPTICS	Basic principles – Harmonic generation – Second harmonic generation – Phase matching – Third harmonic generation – Optical mixing – Parametric generation of light – Self-focusing of light
UNIT V: MAGNETO-OPTICS AND ELECTRO-OPTICS	Magneto-optical effects – Zeeman effect – Inverse Zeeman effect – Faraday effect – Voigt effect – Cotton-mouton effect – Kerr magneto- optic effect – Electro-optical effects – Stark effect – Inverse stark effect – Electric double refraction – Kerr electro-optic effect – Pockels electro-optic effect

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. B. B. Laud, 2017, Lasers and Non – Linear Optics, 3 rd Edition, New Age International (P) Ltd. 2. Ajoy Ghatak, 2017, Optics, 6 th Edition, McGraw – Hill Education Pvt.Ltd. 3. William T. Silfvast, 1996, Laser Fundamentals Cambridge University Press, New York 4. J. Peatros, Physics of Light and Optics, a good (and free!) electronic book 5. B. Saleh, and M. Teich, Fundamentals of Photonics, Wiley-Interscience,
REFERENCE BOOKS	1. F. S. Jenkins and H. E. White, 1981, Fundamentals of Optics, (4 th Edition), McGraw – Hill International Edition. 2. Dieter Meschede, 2004, Optics, Light and Lasers, Wiley – VCH, Varley GmbH. 3. Lipson, S. G. Lipson and H. Lipson, 2011, Optical Physics, 4 th Edition, Cambridge University Press, New Delhi, 2011. 4. Y. B. Band, Light and Matter, Wiley and Sons (2006) 5. R. Guenther, Modern Optics, Wiley and Sons (1990)
WEB SOURCES	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

COURSE OUTCOMES:

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

CO1	Discuss the transverse character of light waves and different polarization phenomenon	K1
CO2	Discriminate all the fundamental processes involved in laser devices and to analyze the design and operation of the devices	K2
CO3	Demonstrate the basic configuration of a fiber optic – communication system and advantages	K3, K4
CO4	Identify the properties of nonlinear interactions of light and matter	K4
CO5	Interpret the group of experiments which depend for their action on an applied magnetism and electric field	K5
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) and LOW (1).

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	3	3	3	3	3	3
CO2	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) and Low (1)

Elective – 8. ADVANCED MATHEMATICAL PHYSICS	I YEAR – SECOND SEMESTER
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Subject Code	Subject Name	Category	L	T	P	Credits	Inst. Hours	Marks
23PHYE204	ADVANCED MATHEMATICAL PHYSICS	ELECTIVE	4			3	4	75

Pre-Requisites
Good knowledge in basic mathematics
Learning Objectives
➤ To educate and involve students in the higher level of mathematics and mathematical methods relevant and applicable to Physics.

UNITS	Course Details
UNIT I: DISCRETE GROUPS	Definition of a group, subgroup, class, Lagrange's theorem, invariant subgroup, Homomorphism and isomorphism between two groups. Representation of a group, unitary representations, reducible and irreducible representations Schur's lemmas, orthogonality theorem, character table, reduction of Kronecker product of representations, criterion for irreducibility of a representation.
UNIT II: CONTINUOUS GROUPS	Infinitesimal generators, Lie algebra; Rotation group, representations of the Lie algebra of the rotation group, representation of the rotation group, D- matrices and their basic properties. Addition of two angular momenta and C.G. coefficients, Wigner-Eckart theorem.
UNIT III: SPECIAL UNITARY GROUPS	Definition of unitary, unimodular groups SU (2) and SU(3). Lie algebra of SU(2). Relation between SU(2) and rotation group. Lie algebra of SU(3)- Gellmann's matrices. Cartan form of the SU(3). Lie algebra, roots and root diagram for SU(3). Weights and their properties, weight diagrams for the irreducible representations 3, 3*, 6, 6, 8, 10 and 10 of SU(3). Direct product of two SU(3) representations, Young tableaux method of decomposition of products of IR's illustrations with the representations of dim<10. C.G. coefficients for 3 x 3* and 3 x 6 representations. SU(3) symmetry in elementary particle physics, quantum numbers of hadrons and SU(2) and SU(3) classification of hadrons.
UNIT IV: TENSORS	Cartesian vectors and tensors illustration with moment of inertia, conductivity, dielectric tensors. Four vector in special relativity, vectors and tensors under Lorentz transformations, Illustration from physics. Vectors and tensors under general co-ordinate transformations, contravariant and covariant vectors and tensors, mixed tensors; tensor algebra, addition, subtraction, direct product of tensors, quotient theorem, symmetric and antisymmetric tensors.
UNIT V: TENSOR CALCULUS	Parallel transport, covariant derivative, affine connection. Metric tensor. Expression for Christoffel symbols in terms of and its derivatives (assuming $Dg = 0$). Curvature tensor, Ricci tensor and Einstein tensor. Bianchi identities, Schwarzschild solution to the Einstein equation $G=0$.

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. A. W. Joshi, Group Theory for Physicists 2. D. B. Lichtenberg, Unitary Symmetry and Elementary Particles 3. E. Butkov, Mathematical Physics 4. J. V. Narlikar, General Relativity & Cosmology 5. R. Geroch, Mathematical Physics, The University of Chicago press(1985).
REFERENCE BOOKS	1. M. Hamermesh <i>Group Theory</i> 2. M. E. Rose: Elementary Theory of Angular Momentum 3. Georgi : Lie Groups for Physicists 4. E. A. Lord: Tensors, Relativity & Cosmology 5. P. Szekeres, A course in modern mathematical physics: Groups, Hilbert spaces and differential geometry, Cambridge University Press.
WEB SOURCES	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

COURSE OUTCOMES:

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

CO1	Gained knowledge of both discrete and continuous groups	K1
CO2	Apply various important theorems in group theory	K3
CO3	Construct group multiplication table, character table relevant to important branches of physics.	K5
CO4	Equipped to solve problems in tensors	K4, K5
CO5	Developed skills to apply group theory and tensors to peruse research	K2, K3
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) and LOW (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) and Low (1)

Elective – 9. PLASMA PHYSICS	I YEAR – SECOND SEMESTER
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Subject Code	Subject Name	Category	L	T	P	Credits	Inst. Hours	Marks
23PHYE204	PLASMA PHYSICS	ELECTIVE	4			3	4	75

Pre-Requisites
Fundamentals of Electricity and Magnetism, Electromagnetic theory, Maxwell's equation, Basic knowledge of electrical and electronics instrumentation.
Learning Objectives
➤ To explore the plasma universe by means of in-site and ground-based observations. ➤ To understand the model plasma phenomena in the universe. ➤ To explore the physical processes which occur in the space environment.

UNITS	Course Details
UNIT I: FUNDAMENTAL CONCEPTS OF PLASMA	Kinetic pressure in a partially ionized - mean free path and collision cross section - Mobility of charged particles - Effect of magnetic field on the mobility of ions and electrons-Thermal conductivity- Effect of magnetic field-Quasi- neutrality of plasma Debye shielding distance – Optical properties of plasma.
UNIT II: MOTION OF CHARGED PARTICLES IN ELECTRIC AND MAGNETIC FIELD	Particle description of plasma- Motion of charged particle in electrostatic - field- Motion of charged particle in uniform magnetic field - Motion of charged particle in electric and magnetic fields- Motion of charged particle in inhomogeneous magnetic field - Motion of charged particle in magnetic mirror confinement - motion of an electron in a time varying electric field-Magneto- hydrodynamics – Magneto hydrodynamic equations – Condition for magnetohydrodynamic behaviour.
UNIT III: PLASMA OSCILLATIONS AND WAVES	Introduction, theory of simple oscillations - electron oscillation in a plasma – Derivations of plasma oscillations by using Maxwell's equation - Ion oscillation and waves in a magnetic field - thermal effects on plasma oscillations - Landau damping - Hydro magnetic waves - Oscillations in an electron beam.
UNIT IV: PLASMA DIAGNOSTICS TECHNIQUES	Single probe method - Double probe method - Use of probe technique for measurement of plasma parameters in magnetic field - microwave method - spectroscopic method - laser as a tool for plasma diagnostics-X-ray diagnostics of plasma - acoustic method - conclusion.
UNIT V: APPLICATIONS OF PLASMA PHYSICS	Magnetohydrodynamic Generator - Basic theory - Principle of Working- Fuel in MHD Generator - Generation of Microwaves Utilizing High Density Plasma - Plasma Diode.
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. Plasma Physics- Plasma State of Matter - S. N. Sen, Pragati Prakashan, Meerut. 2. Introduction to Plasma Physics-M. Uman 3. Krall, N. A., and A. W. Trivelpiece. Principles of Plasma Physics. Berkeley, CA: San Francisco Press, 1986. ISBN: 9780911302585. Tanenbaum, B. S. Plasma Physics. New York, NY: McGraw-Hill, 1967. ISBN: 9780070628120. 4. Goldston, R. J., and P. H. Rutherford. Introduction to Plasma Physics. Philadelphia, PA: IOP Publishing, 1995. ISBN: 9780750301831. 5. Hutchinson, I. H. Principles of Plasma Diagnostics. Cambridge, UK: Cambridge University Press, 2005. ISBN: 9780521675741.
REFERENCE BOOKS	1. Chen, F. F. Introduction to Plasma Physics. 2nd ed. New York, NY: Springer, 1984. ISBN: 9780306413322. 2. Introduction to Plasma Theory-D.R. Nicholson 3. Shohet, J. L. The Plasma State. San Diego, CA: Academic Press Inc., 1971. ISBN: 9780126405507. 4. Hazeltine, R. D., and F. L. Waelbroeck. The Framework of Plasma Physics. Boulder, CO: Westview Press, 2004. ISBN: 9780813342139. 5. Huddleston, R.H. and S.L. Leonard. Plasma Diagnostic Techniques. San Diego, CA: Academic Press, 1965
WEB SOURCES	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

COURSE OUTCOMES:

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

CO1	Understand the collision, cross section of charged particles and to able to correlate the magnetic effect of ion and electrons in plasma state.	K1, K2
CO2	Understand the plasma and learn the magneto-hydrodynamics concepts applied to plasma.	K2
CO3	Explore the oscillations and waves of charged particles and thereby apply the Maxwell's equation to quantitative analysis of plasma.	K1, K3
CO4	Analyze the different principle and techniques to diagnostics of plasma.	K2, K5
CO5	Learn the possible applications of plasma by incorporating various electrical and electronic instruments.	K4

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) and LOW (1).

	PO 1	PO2	PO 3	PO4	PO5	PO6	PO7	PO 8	PO9	PO10
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) and Low (1)

Elective – 10. MICROPROCESSOR 8085 AND MICROCONTROLLER 8051	I YEAR – SECOND SEMESTER
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Subject Code	Subject Name	Category	L	T	P	Credits	Inst. Hours	Marks
23PHYE205	MICROPROCESSOR 8085 AND MICROCONTROLLER 8051	ELECTIVE	4			3	4	75

Pre-Requisites

Knowledge of number systems and binary operations

Learning Objectives

- To provide an understanding of the architecture and functioning of microprocessor 8085A and to the methods of interfacing I/O devices and memory to microprocessor
- To introduce 8085A programming and applications and the architecture and instruction sets of microcontroller 8051

UNITS	Course Details
UNIT I: 8085 PROGRAMMING, PERIPHERAL DEVICES AND THEIR INTERFACING	Instruction set - Addressing modes - Programming techniques - Memory mapped I/O scheme- I/O mapped I/O scheme - Memory and I/O interfacing- Data transfer schemes - Interrupts of 8085 - Programmable peripheral interface (PPI) - Control group and control word- Programmable DMA controller - Programmable interrupt controller – Programmable communication interface - Programmable counter /interval timer.
UNIT II: 8085 INTERFACING APPLICATIONS	Seven segment display interface - Interfacing of Digital to Analog converter and Analog to Digital converter - Stepper motor interface - Measurement of electrical quantities – Voltage and current) Measurement of physical quantities (Temperature and strain).
UNIT III: 8051 MICRO CONTROLLER HARDWARE	Introduction – Features of 8051 – 8051 Microcontroller Hardware: Pin-out 8051, Central Processing Unit (CPU), internal RAM, Internal ROM, Register set of 8051 – Memory organization of 8051 – Input/ Output pins, Ports and Circuits – External data memory and program memory: External program memory, External data memory.
UNIT IV: 8051 INSTRUCTION SET AND ASSEMBLY LANGUAGE PROGRAMMING	Addressing modes – Data moving (Data transfer) instructions: Instructions to Access external data memory, external ROM / program memory, PUSH and POP instructions, Data exchange instructions – Logical instructions: byte and bit level logical operations, Rotate and swap operations – Arithmetic instructions: Flags, Incrementing and decrementing, Addition, Subtraction, Multiplication and division, Decimal arithmetic – Jump and CALL instructions: Jump and Call program range, Jump, Call and subroutines – Programming.
UNIT V: INTERRUPT PROGRAMMING AND INTERFACING TO EXTERNAL WORLD	8051 Interrupts – Interrupt vector table – Enabling and disabling an interrupt – Timer interrupts and programming – Programming external hardware interrupts– Serial communication interrupts and programming – Interrupt priority in the 8051 : Nested interrupts , Software triggering of interrupt. LED Interface Seven segment display interface- Interfacing of Digital to Analog converter and Analog to Digital converter – Stepper motor interface - Measurement of electrical quantities – Voltage and current) Measurement of physical quantities (Temperature and strain).
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. A. NagoorKani, Microprocessors & Microcontrollers, RBA Publications(2009).
2. A. P. Godse and D. A. Godse, Microprocessors, Technical Publications,Pune (2009).
3. Ramesh Gaonkar, Microprocessor Architecture, Programming and Applications with 8085, Penram International Publishing (2013).
4. B. Ram, Fundamentals of Microprocessors & Microcontrollers,Dhanpat Rai publications New Delhi (2016).
5. V. Vijayendran, 2005, Fundamentals of Microprocessor-8085I, 3rd Edition S.Visvanathan Pvt, Ltd.

REFERENCEBOOKS

1. Douglas V. Hall, Microprocessors and Interfacing programming and Hardware, Tata Mc Graw Hill Publications (2008)
2. Muhammad Ali Mazidi, Janice GillispieMazidi, Rolin D. Mckinlay, The 8051 Microcontroller and Embedded Systems, Pearson Education (2008).
3. Barry B. Brey, 1995, The Intel Microprocessors 8086/8088, 80186, 80286, 80386 and 80486, 3rd Edition, Prentice- Hall of India, New Delhi.
4. J. Uffrenbeck, -The 8086/8088 Family-Design, Programming and Interfacing, Software, Hardware and ApplicationsI, Prentice-Hall of India, New Delhi.
5. W. A. Tribel, Aytar Singh, -The 8086/8088 Microprocessors: Programming, Interfacing, Software, Hardware and ApplicationsI, Prentice-Hall of India, New Delhi.

WEB SOURCES

https://www.tutorialspoint.com/microprocessor/microprocessor_8085_architecture.html
<http://www.electronicengineering.nbcafe.in/peripheral-mapped-io-interfacing/>
<https://www.geeksforgeeks.org/programmable-peripheral-interface-8255/>
<http://www.circuitstoday.com/8051-microcontroller>
<https://www.elprocus.com/8051-assembly-language-programming/>

COURSE OUTCOMES:

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

CO1	Gain knowledge of architecture and working of 8085 microprocessor.	K1
CO2	Get knowledge of architecture and working of 8051 Microcontroller.	K1
CO3	Be able to write simple assembly language programs for 8085A microprocessor.	K2, K3
CO4	Able to write simple assembly language programs for 8051 Microcontroller.	K3, K4
CO5	Understand the different applications of microprocessor and microcontroller.	K3, K5
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) 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) and Low (1)

Subject Code	Subject Name	Category	L	T	P	Credits	Inst. Hours	Marks
23PHYE205	ADVANCED SPECTROSCOPY	ELECTIVE	4			3	4	75

Pre-Requisites

Basic knowledge of group theory, abstract thinking ability, lasers, chemical bonds and molecular structures

Learning Objectives

- Helps students understand and appreciate spectroscopy as a sufficiently broad field in which many sub disciplines exist.
- Make them appreciate each of these specific techniques with numerous implementations.
- To realize the progress in this field that is rapid, resulting in improved instrument capabilities and an ever-widening range of applications.
- To apply group theory in spectroscopy to shed light on molecular symmetry and determine important physical parameters.

UNITS	Course Details
UNIT I: MOLECULAR SPECTROSCOPY AND GROUP THEORY	Group axioms –subgroup, simple group, Abelian group, cyclic group, order of a group, class- Lagrange's theorem statement and proof - Symmetry operations and symmetry elements - Application: construction of group multiplication table (not character table) for groups of order 2, 3, cyclic group of order 4, noncyclic group of order 4 – reducible and irreducible representations- Unitary representations – Schur's lemmas – Great orthogonality theorem - point group -Simple applications : Symmetry operations of water and ammonia- Construction of character table for C_{2v} (water) and C_{3v} (ammonia) molecules
UNIT II: LASER SPECTROSCOPY	Lasers as Spectroscopy Light sources – Special Characteristics of Laser emission- ultra short pulses- laser cooling -Single and multi-mode lasers- Laser tunability- Fluorescence spectroscopy with lasers- Laser Raman Spectroscopy – Non-linear Spectroscopy – Applications of Laser Spectroscopy in medical fields, materials science research
UNIT III: MOSSBAUER SPECTROSCOPY	Basic idea of Mossbauer spectroscopy - Principle- Mossbauer effect- Recoilless emission and absorption- Chemical shift -Effect of electric and magnetic fields – hyperfine interactions- instrumentation- Applications: understanding molecular and electronic structures
UNIT IV: XRAY PHOTOELECTRON SPECTROSCOPY	Principle – XPS spectra and its interpretation- ESCA-EDAX- other forms of XPS – chemical shift - Applications: - stoichiometric analysis- electronic structure- XPES techniques used in astronomy, glass industries, paints and in biological research
UNIT V: MOLECULAR MODELLING	Determination of force constants- force field from spectroscopic data- normal coordinate analysis of a simple molecule (H_2O) – analyzing thermodynamic functions, partition functions, enthalpy, specific heat and related parameters from spectroscopic data- molecular modelling using data from various spectroscopic studies
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. William Kemp, 2019, Organic Spectroscopy (2nd Edition) MacMillan, Indian Edition.
2. C N Banwell and McCash, 1994, Fundamentals of Molecular Spectroscopy, 4th Edition, Tata McGraw-Hill, New Delhi.
3. D.N. Satyanarayana, 2001, *Vibrational Spectroscopy and Applications*, New Age International Publication.
4. B.K. Sharma, 2015, *Spectroscopy*, Goel Publishing House Meerut.
5. J M Hollas, 2002, Basic Atomic and Molecular Spectroscopy, Royal Society of Chemistry, RSC, Cambridge.

REFERENCE BOOKS

1. Demtroder. W, Laser Spectroscopy: Basic concepts and Instrumentation, Springer Link.
2. B. P. Straughan and S. Walker, 1976, Spectroscopy Vol.I., Chapman and Hall, New York.
3. J L McHale, 2008, Molecular Spectroscopy, Pearson Education India, New Delhi.
4. David. L. Andrews, Introduction to Laser Spectroscopy, Springer, 2020
5. Kalsi. P.S, 2016, Spectroscopy of Organic Compounds (7th Edition) New Age International Publishers.

WEB SOURCES

1. Fundamentals of Spectroscopy - 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

COURSE OUTCOMES:

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

CO1	Comprehend set of operations associated with symmetry elements of a molecule, apply mathematical theory while working with symmetry operations. Apply mathematical theory while working with symmetry operations. To use group theory as a tool to characterize molecules.	K1, K2
CO2	Align with the recent advances in semiconductor laser technology combined sensitive spectroscopic detection techniques.	K3
CO3	Understand principle behind Mossbauer spectroscopy and apply the concepts of isomer shift and quadrupole splitting to analyse molecules.	K2, K3
CO4	Assimilate this XPES quantitative technique and the instrumentation associated with this, as applied in understanding surface of materials.	K3, K4
CO5	Employ IR and Raman spectroscopic data along with other data for structural investigation of molecules. Analyze thermodynamic functions and other parameters to evolve molecular models.	K5
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) and LOW (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) and Low (1)

Elective – 12. MEDICAL PHYSICS	I YEAR – SECOND SEMESTER
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SubjectCode	Category	Subject Name	L	T	P	Credits	Inst. Hours	Marks
23PHYE205	ELECTIVE	MEDICAL PHYSICS	4			3	4	75

Pre-Requisites
Fundamentals of physiological concepts, Basics of instruments principle,

Learning Objectives
➤ To understand the major applications of Physics to Medicine ➤ To study the aid of different medical devices such as X-ray machines, gamma camera, accelerator and nuclear magnetic resonance. ➤ To outline the principles of Physics of different medical radiation devices and their modern advances, especially in medical radiation therapy and different applications in medical physics. ➤ To introduce the ideas of Radiography. ➤ To form a good base for further studies like research.

UNITS	Course Details
UNIT I: X-RAYS AND TRANSDUCERS	Electromagnetic Spectrum – Production of X-Rays – X-Ray Spectrum – Bremsstrahlung – Characteristic X-Ray – X-Ray Tubes – Coolidge Tube – X-Ray Tube Design – Thermistors – photoelectric transducers – Photo voltaic cells – photoemissive cells – Photoconductive cells – piezoelectric transducer
UNIT II: BLOOD PRESSURE MEASUREMENTS	Introduction – sphygmomanometer – Measurement of heart rate – basic principles of electrocardiogram (ECG) – Basic principles of electro- neurography (ENG) – Basic principles of magnetic resonance imaging (MRI).
UNIT III: 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 IV: MEDICAL IMAGING PHYSICS	Radiological Imaging – Radiography – Filters – Grids – Cassette – X-Ray Film – Film processing – Fluoroscopy – Computed Tomography Scanner – Principal Function – Display – Mammography – Ultrasound Imaging – Magnetic Resonance Imaging – Thyroid Uptake System – Gamma Camera (Only Principle, Function and display)
UNIT V: RADIATION PROTECTION	Principles of Radiation Protection – Protective Materials – Radiation Effects – Somatic – Genetic Stochastic and Deterministic Effect – Personal Monitoring Devices – TLD Film Badge – Pocket Dosimeter
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. Dr. K. Thayalan, <i>Basic Radiological Physics</i> , Jayapee Brothers Medical Publishing Pvt. Ltd. New Delhi, 2003. 2. Curry, Dowdey and Murry, <i>Christensen's Physics of Diagnostic Radiology</i> : Lippincott Williams and Wilkins, 1990. 3. FM Khan, <i>Physics of Radiation Therapy</i> , William and Wilkins, 3rd ed, 2003. 4. D. J. Dewhurst, <i>An Introduction to Biomedical Instrumentation</i> , 1st ed, Elsevier Science, 2014. 5. R.S. Khandpur, <i>Hand Book of Biomedical Instrumentations</i> , 1st ed, TMG, New Delhi, 2005.
REFERENCE BOOKS	1. Muhammad Maqbool, <i>An Introduction to Medical Physics</i> , 1st ed, Springer International Publishing, 2017. 2. Daniel Jiráček, František Vítek, <i>Basics of Medical Physics</i> , 1st ed, Charles University, Karolinum Press, 2018 3. Anders Brahme, <i>Comprehensive Biomedical Physics</i> , Volume 1, 1st ed, Elsevier Science, 2014. 4. K. Venkata Ram, <i>Bio-Medical Electronics and Instrumentation</i> , 1st ed, Galgotia Publications, New Delhi, 2001. 5. John R. Cameron and James G. Skofronick, 2009, <i>Medical Physics</i> , John Wiley Inter science Publication, Canada, 2nd edition.
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-deepaj-adhikary/78 5. https://www.modulight.com/applications-medical/

COURSE OUTCOMES:

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

CO1	Learn the fundamentals, production and applications of X-rays.	K1
CO2	Understand the basics of blood pressure measurements. Learn about sphygmomanometer, ECG, ENG and basic principles of MRI.	K2
CO3	Apply knowledge on Radiation Physics	K3
CO4	Analyze Radiological imaging and filters	K4
CO5	Assess the principles of radiation protection	K5
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) 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) and Low (1)

Elective – 13. PHYSICS OF NANOSCIENCE AND TECHNOLOGY	II YEAR – THIRD SEMESTER
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Subject Code	Subject Name	Category	L	T	P	Credits	Inst. Hours	Marks
23PHYE305	PHYSICS OF NANOSCIENCE AND TECHNOLOGY	ELECTIVE	3			3	3	75

Pre-Requisites
Basic knowledge in Solid State Physics
Learning Objectives
➤ Physics of Nanoscience and Technology is concerned with the study, creation, manipulation and applications at nanometer scale. ➤ To provide the basic knowledge about nanoscience and technology. ➤ To learn the structures and properties of nanomaterials. ➤ To acquire the knowledge about synthesis methods and characterization techniques and its applications.

UNITS	Course Details
UNIT I: FUNDAMENTALS OF NANOSCIENCE AND TECHNOLOGY	Fundamentals of NANO – Historical Perspective on Nanomaterial and Nanotechnology – Classification of Nanomaterials – Metal and Semiconductor Nanomaterials - 2D, 1D, 0D nanostructured materials - Quantum dots – Quantum wires – Quantum wells - Surface effects of nanomaterials.
UNIT II: PROPERTIES OF NANOMATERIALS	Physical properties of Nanomaterials: Melting points, specific heat capacity, and lattice constant - Mechanical behavior: Elastic properties – strength - ductility - superplastic behavior - Optical properties: - Surface Plasmon Resonance – Quantum size effects - Electrical properties - Conductivity, Ferroelectrics and dielectrics - Magnetic properties – super para magnetism – Diluted magnetic semiconductor (DMS).
UNIT III: SYNTHESIS AND FABRICATION	Physical vapour deposition - Chemical vapour deposition - sol-gel – Wet deposition techniques - electrochemical deposition method – Plasma arching - Electrospinning method - ball milling technique - pulsed laser deposition - Nanolithography: photolithography – Nanomanipulator.
UNIT IV: CHARACTERIZATION TECHNIQUES	Powder X-ray diffraction – X-ray photoelectron spectroscopy (XPS) - UV-visible spectroscopy – Photoluminescence - Scanning electron microscopy (SEM) - Transmission electron microscopy (TEM) - Scanning probe microscopy (SPM) - Scanning tunneling microscopy (STM) – Vibrating sample Magnetometer.
UNIT V: APPLICATIONS OF NANOMATERIALS	Sensors: Nanosensors based on optical and physical properties - Electrochemical sensors – Nano-biosensors. Nano Electronics: Nanobots - display screens - GMR read/write heads - Carbon Nanotube Emitters – Photocatalytic application: Air purification, water purification - Medicine: Imaging of cancer cells – biological tags - drug delivery - photodynamic therapy - Energy: fuel cells - rechargeable batteries - supercapacitors - photovoltaics.
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. A textbook of Nanoscience and Nanotechnology, Pradeep T., Tata McGraw-Hill Publishing Co. (2012). 2. Principles of Nanoscience and Nanotechnology, M.A. Shah, Tokeer Ahmad, Narosa Publishing House Pvt Ltd., (2010). 3. Introduction to Nanoscience and Nanotechnology, K. K. Chattopadhyay and A.N. Banerjee, PHI Learning Pvt. Ltd., New Delhi, (2012). 4. Nanostructured Materials and Nanotechnology, Hari Singh Nalwa, Academic Press, (2002). 5. Nanotechnology and Nanoelectronics, D.P. Kothari, V. Velmurugan and Rajit Ram Singh, Narosa Publishing House Pvt. Ltd, New Delhi. (2018)
REFERENCE BOOKS	1. Nanostructures and Nanomaterials – Huozhong Gao – Imperial College Press (2004). 2. Richard Booker and Earl Boysen, (2005) Nanotechnology, Wiley Publishing Inc. USA 3. Nano particles and Nano structured films; Preparation, Characterization and Applications, J. H. Fendler John Wiley and Sons. (2007) 4. Textbook of Nanoscience and Nanotechnology, B. S. Murty, et al., Universities Press. (2012) 5. The Nanoscope (Encyclopedia of Nanoscience and Nanotechnology), Dr. Parag Diwan and Ashish Bharadwaj (2005) Vol. IV - Nanoelectronics Pentagon Press, New Delhi.

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

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

CO1	Understand the basic of nanoscience and explore the different types of nanomaterials and should comprehend the surface effects of the nanomaterials.	K1, K2
CO2	Explore various physical, mechanical, optical, electrical and magnetic properties of nanomaterials.	K1
CO3	Understand the process and mechanism of synthesis and fabrication of nanomaterials.	K2, K3
CO4	Analyze the various characterization of Nano-products through diffraction, spectroscopic, microscopic and other techniques.	K4
CO5	Apply the concepts of nanoscience and technology in the field of sensors, robotics, purification of air and water and in the energy devices.	K3
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) and LOW (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) and Low (1)

Elective – 14. SOLID WASTE MANAGEMENT	II YEAR – THIRD SEMESTER
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SubjectCode	Subject Name	Category	L	T	P	Credits	Inst. Hours	Marks
23PHYE305	SOLID WASTEMANAGEMENT	ELECTIVE	3			3	3	75

Pre-Requisites
Basic knowledge of solid waste and its type

Learning Objectives
➤ To gain basic knowledge in solid waste management procedures ➤ To gain industry exposure and be equipped to take up a job. ➤ To harness entrepreneurial skills. ➤ To analyze the status of solid waste management in the nearby areas. ➤ To sensitize the importance of healthy practices in waste managements

UNITS	Course Details
UNIT I: SOLID WASTE MANAGEMENT	Introduction - Definition of solid waste - Types – Hazardous Waste: Resource conservation and Renewal act – Hazardous Waste: Municipal Solid waste and non-municipal solid waste.
UNIT II: SOLID WASTE CHARACTERISTICS	Solid Waste Characteristics: Physical and chemical characteristics -SWM hierarchy - factors affecting SW generation
UNIT III: TOOLS AND EQUIPMENT	Tools and equipment - TransportationComposting and land filling technique – Disposal techniques
UNIT IV: ECONOMIC DEVELOPMENT	SWM for economic development and environmental protection Linking SWM and climate change and marine litter.
UNIT V: INDUSTRIAL VISIT	SWM Industrial visit – data collection and analysis - presentation
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. Handbook of Solid Waste Management /Second Edition, George Tchobanoglous, McGraw Hill (2002). 2. Prospects and Perspectives of Solid Waste Management, Prof. BB Hosett, New Age International (P) Ltd (2006). 3. Solid and Hazardous Waste Management, Second Edition, M.N Rao, BSP /BS Publications Books (.2020 4. Integrated Solid Waste Management Engineering Principles and Management, Tchobanoglous, McGraw Hill (2014). 5. Solid Waste Management (SWM), Vasudevan Rajaram, PHI learning private limited, 2016
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REFERENCE BOOKS	1. Municipal Solid Waste Management, Christian Ludwig, Samuel Stucki, Stefanie Hellweg, Springer Berlin Heisenberg, 2012 2. Solid Waste Management Bhide A. D Indian National Scientific Documentation Centre, New Delhi Edition 1983 ASIN: B0018MZ0C2 Solid Waste Tchobanoglous George; Kreith, Frank McGrawHill Publication, New Delhi 2002, ISBN 9780071356237 3. Environmental Studies Manjunath D. L. Pearson Education Publication, New Delhi, 2006 ISBN-I3: 978-8131709122 4. Solid Waste Management Sasikumar K. PHI learning, New Delhi, 2009 ISBN 8120338693
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=Cj0KCQjwuuKXBhCRARIIsA-gM0iVpismAJN93CHA1sX6NuNeOKLXfQJ_jxHCOVH3QXjJ1iACq30KofoaAmFsEALw_wcB 4. https://images.app.goo.gl/tYiW2gUPfS2cxdD28 5. https://amzn.eu/d/5VUSTDI

COURSE OUTCOMES:

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

CO1	Gained knowledge in solid waste management	K1
CO2	Equipped to take up related job by gaining industry exposure	K5
CO3	Develop entrepreneurial skills	K3
CO4	Will be able to analyze and manage the status of the solid wastes in the nearby areas	K4
CO5	Adequately sensitized in managing solid wastes in and around his/her locality	K5
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) and LOW (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) and Low (1)

Elective - 15. SEWAGE AND WASTEWATER TREATMENT AND REUSE				II YEAR –THIRD SEMESTER				
Subject Code	Subject Name	Category	L	T	P	Credits	Inst. Hours	Marks
23PHYE305	SEWAGE AND WASTE WATER TREATMENT AND REUSE	ELECTIVE	3			3	3	75

Pre-Requisites	
Basic knowledge of classification of sewage and solid waste and its harmful effects.	
Learning Objectives	
➤ To gain basic knowledge in sewage and waste water Treatment procedures ➤ To gain industry exposure and be equipped to take up job. ➤ To harness entrepreneurial skills. ➤ To analyze the status of sewage and waste water management in the nearby areas. ➤ To sensitize the importance of healthy practices in waste water management.	

UNITS	Course Details
UNIT I: RECOVERY & REUSE OF WATER	Recovery & Reuse of water from Sewage and Waste water: Methods of recovery: Flocculation - Sedimentation - sedimentation with coagulation - Filtration - sand filters - pressure filters - horizontal filters - vector control measures in industries - chemical and biological methods of vector eradication
UNIT II: DISINFECTION	Disinfection: Introduction to disinfection and sterilization: Disinfectant - UV radiation - Chlorination - Antisepsis - Sterilant - Aseptic and sterile - Bacteriostatic and Bactericidal - factors affecting disinfection.
UNIT III: CHEMICAL DISINFECTION	Chemical Disinfection: Introduction - Theory of Chemical Disinfection - Chlorination Other Chemical Methods - Chemical Disinfection Treatments Requiring - Electricity - Coagulation/Flocculation Agents as Pretreatment - Disinfection By-Products(DBPs)
UNIT IV: PHYSICAL DISINFECTION	Physical Disinfection: Introduction - Ultraviolet Radiation - Solar Disinfection - Heat Treatment - Filtration Methods - Distillation - Electrochemical Oxidation Water Disinfection by Microwave Heating.
UNIT V: INDUSTRIAL VISIT	Industrial visit – data collection and analysis - presentation
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. Drinking water and disinfection technique, Anirudhha Balachandra.CRC press (2013) 2. Design of Water and Wastewater Treatment Systems (CV-424/434),Shashi Bushan,(2015) Jain Bros 3. Integrated Water Resources Management, Sarbhukan M M, CBS PUBLICATION (2013) 4. C.S. Rao, Environmental Pollution Control Engineering, New Age International, 2007 5. S.P. Mahajan, Pollution control in process industries, 27th Ed. TataMcGraw Hill Publishing Company Ltd., 2012.
REFERENCEBOOKS	1.Handbook of Water and Wastewater Treatment Plant Operations, Frank. R Spellman, CRC Press, 2020 2.Wastewater Treatment Technologies, Mritunjay Chaubey, Wiley,2021. 3.Metcalf and Eddy, Wastewater Engineering, 4th ed., McGraw HillHigher Edu., 2002. 4.W. Wesley Eckenfelder, Jr., Industrial Water Pollution Control, 2ndEdn., McGraw Hill Inc., 1989 5.Lancaster, Green Chemistry: An Introductory Text, 2nd edition,RSC publishing, 2010.
WEB SOURCES	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=Cj0KCQjwuKXBhCRARIsAC-gM0iVpismAJN93CHA1sX6NuNeOKLXfQJjxHCOVH3QXjJ1iACq30KofoaAmFsEALw_wcB 4. https://www.meripustak.com&gclid=Cj0KCQjwuKXBhCRARIsAC-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&hvrnd=4351305881865063672&hvpone=&hvptwo=&hvqmt=&hvdev=m&hvdvcmdl=&hvlocint=&hvlocphy=9061971&hvtargid=pla-890646066127&psc=1&ext_vrnc=hi

COURSE OUTCOMES:

CO1	Gained knowledge in solid waste management	K1
CO2	Equipped to take up related job by gaining industry exposure	K5
CO3	Develop entrepreneurial skills	K3
CO4	Will be able to analyze and manage the status of the solid wastes in the nearby areas	K4
CO5	Adequately sensitized in managing solid wastes in and around his/her locality	K5
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;		

MAPPING WITH PROGRAM OUTCOMES:

	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

Elective- VI (Industry/Entrepreneurship)80%P20%T. CHARACTERIZATON OF MATERIALS	II YEAR–FOURTH SEMESTER
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Subject Code	Subject Name	Category	L	T	P	Credits	Inst. Hours	Marks
23PHYE404	CHARACTERIZATON OF MATERIALS	ELECTIVE	1		3	3	4	75

Pre-Requisites
Fundamentals of Heat and Thermodynamics, Basics of Optical systems, Microscopic systems, Electrical measurements and Fundamentals of Spectroscopy.
Learning Objectives
To make the students learn some important thermal analysis techniques. To make the students understand the theory of image formation in an optical microscope and to introduce other specialized microscopic techniques. To make the students learn and understand the principle of working of electron microscopes. To make the students understand some important electrical and optical characterization techniques for semiconducting materials. The basics of x-ray diffraction techniques and some important spectroscopic techniques.

UNITS	Course details
UNIT I THERMAL ANALYSIS	Introduction – thermo gravimetric analysis(TGA)–instrumentation–determination of weight loss and decomposition products–differential thermal analysis(DTA) –cooling curves– differential scanning calorimetry (DSC)–instrumentation–specific heat capacity measurements–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 ELECTRON MICROSCOPY AND ATOMIC FORCE MICROSCOPY	Scanning Electron Microscopy (SEM), FESEM with EDAX, TEM and Atomic force microscopy (AFM), – working principle and Instrumentation – sample preparation– Data -collection, processing and analysis.
UNIT IV ELECTRICAL METHODS AND OPTICAL CHARACTERISATION	Two probe and four probe methods – Hall probe and 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 Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

TEXTBOOKS	1. R.A.Stradling and P.C.Klipstain. Growth and Characterization of semiconductors. Adam Hilger, Bristol, 1990. 2. J.A.Belk. Electron microscopy and microanalysis of crystalline materials. Applied Science Publishers, London, 1979. 3. Lawrence E.Murr. Electron and Ion microscopy and Micro analysis principles and Applications. Marcel Dekker Inc., New York, 1991 4. D.Kealey and P.J.Haines. Analytical Chemistry. Viva Books Private Limited, New Delhi, 2002. 5. Li, Lin, Ashok Kumar. Materials Characterization Techniques. Sam Zhang; CRC Press, (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 Electronic Imaging, Wiley-Liss, Inc. USA, (2001). 3. Tyagi, A.K., Roy, Mainak, Kulshreshtha, S.K., and Banerjee, S., Advanced Techniques for Materials Characterization, Materials Science Foundations (monograph series), Volumes 49–51, (2009). 4. Wendlandt, W.W., Thermal Analysis, John Wiley & Sons, (1986). 5. Wachtman, J.B., Kalman, Z.H., Characterization of Materials, Butterworth Heinemann, (1993)
WEBSOURCES	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

COURSE OUTCOMES:

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

CO1	Describe the TGA, DTA, DSC thermal analysis techniques and make interpretation of the results.	K1, K3
CO2	The concept of image formation in Optical microscope, developments in other specialized microscopes and their applications.	K2
CO3	The working principle 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 experimental techniques with necessary theory.	K3, K4
CO5	The theory and experimental procedure for x-ray diffraction and some important spectroscopic techniques and their applications.	K4, K5
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) and LOW (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

PROJECT WITH VIVA-VOCE

SEMESTER-IV	23PHYD403 - PROJECT	Credit:7 Hours:10
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Learning Objectives:

To develop skill in both experimental and theoretical work by carrying out research in selective area of applied physics.

Course outcomes:

At the end of the course, the students will

CO1: Acquire the practical knowledge of understanding research problems.

CO2: Gain knowledge basic principles of various components of research

CO3: Apply the principles of chemistry in various fields.

CO4: Identify the appropriate spectral techniques an analytical tool to investigate the characteristics of materials.

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
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
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Subject Code	Subject Name	Category	L	T	P	Credits	Inst.Hours	Marks
23PHYS206	SOLAR ENERGY UTILIZATION	ELECTIVE	3		1	2	4	75

Pre-Requisites
Basic knowledge of heat energy, way of transfer of heat, solar energy, materials types
Learning Objectives
➤ To impart fundamental aspects of solar energy utilization. ➤ To give adequate exposure to solar energy related industries ➤ To harness entrepreneurship skills ➤ To understand the different types of solar cells and channelizing them to the different sectors of society ➤ To develop an industrialist mindset by utilizing renewable source of energy

UNITS	Course Details
UNIT I: HEAT TRANSFER & RADIATION ANALYSIS	Conduction, Convection and Radiation Solar Radiation at the earth's surface-Determination of solar time-Solar energy measuring instruments.
UNIT II: SOLAR COLLECTORS	Physical principles of conversion of solar radiation into heat flat Plate collectors – General characteristics-Focusing collector systems-Thermal performance evaluation of optical loss.
UNIT III: SOLAR HEATERS	Types of solar water heater-Solar heating system-Collectors and storage tanks- Solar ponds – Solar cooling systems.
UNIT IV: SOLAR ENERGY CONVERSION	Photo Voltaic principles-Types of solar cells-Crystalline silicon/amorphous silicon and Thermo-electric conversion-process Flow of silicon solar cells-different approaches on the process-texturization, diffusion, Antireflective coatings, metallization.
UNIT V: NANOMATERIALS IN FUEL CELL APPLICATIONS	Use of nanostructures and nano materials in fuel cell technology -high and low temperature fuel cells, cathode and anode reactions, fuel cell catalysts, electrolytes, ceramic catalysts. Use of Nanotechnology in hydrogen production and storage. Industrial visit-data collection and analysis-presentation
UNIT VI: PROFESSIONAL COMPONENTS	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

TEXTBOOKS	1. Solar energy utilization - G.D.Rai–Khanna publishers –Delhi1987. 2. Maheshwar Sharon, Madhuri Sharon, Carbon –Nano forms and Applications, McGraw-Hill, 2010. 3. Soteris A. Kalogirou, „Solar Energy Engineering: Processes and Systems“, Academic Press, London, 2009 4. Tiwari G.N., –Solar Energy –Fundamentals Design, Modelling and applications, Narosa Publishing House, New Delhi, 2002 5. Sukhatme S.P. Solar Energy, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1997.
REFERENCE BOOKS	1. Energy–An Introduction to Physics –R.H.Romer, W.H.Freeman.(1976) 2. Solar energy thermal processes – John A. Drife and William. (1974) 3. John W. Twidell & Anthony D. Weir, „Renewable Energy Resources, 2005 4. John A. Duffie, William A. Beckman, Solar Energy: Thermal Processes, 4th Edition, John Wiley and Sons, 2013 5. Duffie, J.A., Beckman, W.A., –Solar Energy Thermal Processes, John Wiley And Sons, 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

COURSE OUTCOMES:

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

CO1	Gained knowledge in fundamental aspects of solar energy utilization	K1
CO2	Equipped to take up related job by gaining industry exposure	K3
CO3	Develop entrepreneurial skills	K5
CO4	Skilled to approach the needy society with different types of solar cells	K4
CO5	Gained industrialist mindset by utilizing renewable source of energy	K2, K3
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) and LOW(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) and Low (1)

SEC – II PHYSICS FOR MEDICAL INSTRUMENTATION	II YEAR–THIRD SEMESTER
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Subject Code	Subject Name	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-ELECTRIC POTENTIALS	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: IMAGING EQUIPMENTS	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: APPLIED PHYSICS FOR PHYSIOTHERAPY	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 curr

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
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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, Fiaz M.Khan, 2006. 4. Nuclear Medicine physics, Ramesh Chandra, 5 th Edition, Lea and Febiger
WEB SOURCES	https://nptel.ac.in/courses/108/103/108103157/ https://www.studocu.com/en/course/university-of-technology-sydney/medical-devices-and-diagnostics/225692 https://www.technicalsymposium.com/alllecturenotes_biomed.html https://lecturenotes.in/notes/17929-note-for-biomedical-instrumentation-bi-by-deepraj-adhikary/78 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)

	P O 1	P O 2	P O 3	P O 4	P O 5	P O 6	P O 7	P O 8	P O 9	PO 10	PS O1	PS O2	PS O3	PS O4	PS O5	PS O6	PS O7	PS O8
C O1	3	3	3	3	3	3	3	3	3	3	3	3		3		3	3	3
C O2	3	3	3	3	3	3	3	3	3	3	3	3		3		3	3	3
C O3	3	3	3	3	3	3	3	3	3	3	3	3		3		3	3	3
C O4	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
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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 Runge Kutta methods – 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(lz5mqp453edsnp55rrgict55))/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) and LOW (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