



B.S. Abdur Rahman®  
**Crescent**  
Institute of Science & Technology  
Deemed to be University u/s 3 of the UGC Act, 1956

*Regulations 2025  
Curriculum and Syllabi  
(As approved by the 24<sup>th</sup> Academic Council)  
August - 2025*

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**M.Sc. (Physics)**



**REGULATIONS 2025**  
**CURRICULUM AND SYLLABI (I & II Semesters)**  
**(As approved by 24<sup>th</sup> Academic Council)**  
**August - 2025**

**M.SC. PHYSICS**

## **VISION AND MISSION OF THE INSTITUTION**

### **VISION**

B.S. Abdur Rahman Crescent Institute of Science and Technology aspires to be a leader in Education, Training and Research in multidisciplinary areas of importance and to play a vital role in the Socio-Economic progress of the Country in a sustainable manner.

### **MISSION**

- To blossom into an internationally renowned Institute.
- To empower the youth through quality and value-based education.
- To promote professional leadership and entrepreneurship.
- To achieve excellence in all its endeavors to face global challenges.
- To provide excellent teaching and research ambience.
- To network with global Institutions of Excellence, Business, Industry and Research Organizations.
- To contribute to the knowledge base through Scientific enquiry, Applied Research and Innovation.

## **VISION AND MISSION**

### **DEPARTMENT OF PHYSICS**

#### **VISION**

To be a leader in providing quality higher education through well designed programs and undertake research in Physical Sciences and related interdisciplinary areas.

#### **MISSION**

- To provide quality education in the field of Physical Sciences through well designed programs.
- To provide necessary knowledge in Physical Sciences required for all programs in science and engineering.
- To offer quality programs in advanced and applied physical sciences.
- To undertake fundamental, applied and interdisciplinary research in emerging areas.

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**PROGRAMME EDUCATIONAL OBJECTIVES AND OUTCOMES****M.SC. PHYSICS****PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)**

- To identify, formulate, analyze and optimize variety of problems related to various fields of Physics through basic knowledge and to apply the skills and knowledge acquired during the UG studies.
- To acquire knowledge of fundamental laws and principles in wide areas of Physics along with their applications so as to develop strong student competencies in Physics and its applications in a technology-rich, interactive environment.
- To prepare for the successful pursuit of Post Graduate studies and shall have abilities to engage in life-long learning in various fields of Physics and General Science. □ To understand the challenges of a dynamically and globalised changing world adapting their skills through continuous learning and self-improvement.
- To work effectively in bringing interdisciplinary ideas related to diverse environmental skills to excel in technical careers and thrive in Post Graduate and research studies using scientific principles and applications of Physical Science.
- To become effective researcher who will be able to provide lucid summation of the scientific literature on a given topic of study.
- To develop their skills to plan, execute and report the results of extended computational techniques, experimental and theoretical Physics based projects in a research environment.
- To inculcate the sense of ethics, professionalism and effective communication skills amongst graduates improve their workplaces, communities and the society through professional and personal responsibilities and activities of their work.
- To prepare the students to successfully compete for employment and to offer a wide range of experience in research **methods, data analysis to meet the industrial needs.**

## PROGRAMME OUTCOMES (POs)

On successful completion of the programme, the graduates will be able to,

- Design and conduct experiments, as well as to analyze and interpret data.
- Function on interdisciplinary teams with professional and ethical responsibility. Use the modern techniques, skills and sophisticated equipment necessary for research.
- Apply knowledge and skill in the design and development of Electronics circuits to cater to the needs of Electronic Industry.
- Become professionally trained in the area of optical communication, lasers, nonlinear circuits, materials development and characterization including nanomaterials.
- Demonstrate highest standards of actuarial ethical conduct and professional actuarial behavior, critical, interpersonal and communication skills as well as a commitment to life-long learning.
- Successfully compete for employment in the field of Teaching, Research and Industries.

## PROGRAMME SPECIFIC OUTCOME

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

- PSO1:** understand the fundamental and advanced theoretical concepts in core areas of Physics and correlate with real-life applications through logical and analytical reasoning.
- PSO2:** acquire experimental skills and practical knowledge using modern scientific instruments, computational tools, and laboratory techniques and adapt to recent technological advancements in Physics
- PSO3:** Apply the knowledge and to develop the research aptitude required for higher studies, innovation, and research-oriented careers.

**B.S. ABDUR RAHMAN CRESCENT INSTITUTE OF SCIENCE AND  
TECHNOLOGY, CHENNAI – 600 048.  
REGULATIONS 2025**

**M.Tech. / MCA / M.Sc. / M.Com. / M.A. DEGREE PROGRAMMES  
(Under Choice Based Credit System)**

### 1.0 PRELIMINARY DEFINITIONS AND NOMENCLATURE

In these Regulations, unless the context otherwise requires:

- i) **"Programme"** means post graduate degree programme (M.Tech. / MCA / M.Sc. / M.Com. / M.A.)
- ii) **"Branch"** means specialization or discipline of programme like M.Tech. in Structural Engineering, Food Biotechnology etc., M.Sc. in Physics, Chemistry, Actuarial Science, Biotechnology etc.
- iii) **"Course"** means a theory / practical / laboratory integrated theory / mini project / seminar / internship / project and any other subject that is normally studied in a semester like Advanced Concrete Technology, Electro Optic Systems, Financial Reporting and Accounting, Analytical Chemistry, etc.
- iv) **"Institution"** means B.S. Abdur Rahman Crescent Institute of Science and Technology.
- v) **"Academic Council"** means the Academic Council, which is the apex body on all academic matters of this Institute.
- vi) **"Dean (Academic Affairs)"** means the Dean (Academic Affairs) of the Institution who is responsible for the implementation of relevant rules and regulations for all the academic activities.
- vii) **"Dean (Student Affairs)"** means the Dean (Students Affairs) of the Institution who is responsible for activities related to student welfare, conduct of co-curricular, extra-curricular events and discipline in the campus.
- viii) **"Controller of Examinations"** means the Controller of Examinations of the Institution who is responsible for the conduct of examinations and declaration of results.
- ix) **"Dean of the School"** means the Dean of the School of the department concerned.

- x) **“Head of the Department”** means the Head of the Department concerned.

## 2.0 ADMISSION REQUIREMENTS

- 2.1 Students for admission to the first semester of the Master's Degree Programme shall be required to have passed the appropriate degree examination as specified in the clause 3.2 [Eligible entry qualifications for admission to programmes] of this Institution or any other University or authority accepted by this Institution.
- 2.2 The other conditions for admission such as class obtained, number of attempts in the qualifying examination and physical fitness will be as prescribed by the Institution from time to time.

## 3.0 BRANCHES OF STUDY

- 3.1 The various programmes and their mode of study are as follows:

Degree	Mode of Study
M.Tech.	Full Time
MCA	
M.Sc.	
M.Com.	
M.A.	

## 3.2 Programmes offered

S. No.	Name of the Department	Programmes offered
1.	Aeronautical Engineering	M.Tech. (Avionics)
2.	Civil Engineering	M.Tech. (Structural Engineering)
		M. Tech. (Construction Engineering and Project Management)
3.	Mechanical Engineering	M.Tech. (CAD/CAM)
4.	Electrical and Electronics Engineering	M.Tech. (Power Systems Engineering)

S. No.	Name of the Department	Programmes offered
5.	Electronics and Communication Engineering	M.Tech. (VLSI and Embedded Systems)
6.	Computer Science and Engineering	M.Tech. (Computer Science and Engineering)
		M.Tech. (Artificial Intelligence and Data Science)
7.	Information Technology	M.Tech. (Information Technology)
8.	Computer Applications	MCA
9.	Mathematics	M.Sc. (Actuarial Science)
10.	Physics	M.Sc.(Physics)
11.	Chemistry	M.Sc.(Chemistry)
12.	Life Sciences	M.Sc. Biochemistry & Molecular Biology
		M.Sc. Biotechnology
		M.Sc. Microbiology
		M.Sc. Stem Cell Technology
		M.Sc. Clinical Embryology
		M.Tech. Biotechnology
		M.Tech. Food Biotechnology
13.	Commerce	M.Com
14.	Arabic and Islamic Studies	M.A. Islamic Studies

### 3.3 Eligible entry qualifications for admission to programmes

Sl. No.	Programme	Eligibility for Admission in M.Tech. / MCA / M.Sc. / M.Com. / MA Programmes
1.	M.Tech. (Avionics)	B.E. / B.Tech. in Aeronautical Engineering / Aerospace Engineering / Mechanical Engineering / Mechatronics / EEE / ECE / EIE / or Equivalent degree in relevant field.
2.	M.Tech. (Structural	B.E. / B.Tech. in Civil Engineering / Structural

Sl. No.	Programme	Eligibility for Admission in M.Tech. / MCA / M.Sc. / M.Com. / MA Programmes
	Engineering)	Engineering or Equivalent degree in relevant field.
	M. Tech. (Construction Engineering and Project Management)	B.Tech. in Mechanical / Civil / Electrical and Electronics / Geo Informatics / B Plan / B. Des, and B.Arch.
3.	M.Tech. (CAD/CAM)	B.E. / B.Tech. in Mechanical / Automobile / Manufacturing / Production / Industrial / Mechatronics / Metallurgy / Aerospace / Aeronautical / Material Science / Polymer / Plastics / Marine Engineering or Equivalent degree in relevant field.
4.	M.Tech. (Power Systems Engineering)	B.E. / B.Tech. in EEE / ECE / EIE / ICE / Electronics / Instrumentation Engineering or Equivalent degree in relevant field.
5.	M.Tech. (VLSI and Embedded Systems)	B.E. / B.Tech. in ECE / EIE / ICE / EEE / IT or Equivalent degree in relevant field.
6.	M.Tech. (Computer Science and Engineering)	B.E. / B.Tech. in CSE / IT / ECE / EEE / EIE / ICE / Electronics Engineering / MCA or Equivalent degree in relevant field.
	M.Tech. (Artificial Intelligence and Data Science)	B.E. / B.Tech. in CSE / IT / ECE / EEE / EIE / ICE / Electronics Engineering / MCA or Equivalent degree in relevant field.
7.	M.Tech. (Information Technology)	B.E. / B.Tech. in IT / CSE / ECE / EEE / EIE / ICE / Electronics Engineering / MCA or Equivalent degree in relevant field.
8.	MCA	BCA / B.Sc. Computer Science / B.E. / B.Tech. / B.Sc. Mathematics, B.Sc. Physics / Chemistry / B.Com. / BBA / B.A. with Mathematics at graduation level or at 10 + 2 level or equivalent degree in relevant field.
9.	M.Sc. (Actuarial Science)	Any under graduate degree with Mathematics / Statistics as one of the subjects of study at 10 + 2 level.

<b>Sl. No.</b>	<b>Programme</b>	<b>Eligibility for Admission in M.Tech. / MCA / M.Sc. / M.Com. / MA Programmes</b>
10.	M.Sc.(Physics)	B.Sc. in Physics / Applied Science / Electronics / Electronics Science / Electronics & Instrumentation or Equivalent degree in relevant field.
11.	M.Sc.(Chemistry)	B.Sc. in Chemistry / Applied Science or Equivalent degree in relevant field.
12.	M.Sc. Biochemistry & Molecular Biology	B.Sc. in Biotechnology / Biochemistry / Botany / Zoology / Microbiology / Molecular Biology / Genetics or Equivalent degree in relevant field.
	M.Sc. Biotechnology	B.Sc. in Biotechnology / Biochemistry / Botany / Zoology / Microbiology / Molecular Biology / Genetics or Equivalent degree in relevant field.
	M.Sc. Microbiology	B.Sc.in Biotechnology / Biochemistry / Botany / Zoology / Microbiology / Molecular Biology / Genetics or Equivalent degree in relevant field.
	M.Sc. Stem Cell Technology	B.Sc.in Biotechnology / Biochemistry / Botany / Zoology / Microbiology / Molecular Biology / Genetics or Equivalent degree in relevant field.
	M.Sc. Clinical Embryology	B.Sc.in Biotechnology / Biochemistry / Botany / Zoology / Microbiology / Molecular Biology / Genetics or Equivalent degree in relevant field.
	M.Tech. Biotechnology	B.Tech. / B.E. in Biotechnology or Equivalent degree in relevant field.
	M.Tech. Food Biotechnology	B.E. / B.Tech. in Biotechnology / Food Biotechnology / Chemical Engineering / Biochemical Engineering / Industrial Biotechnology or Equivalent degree in relevant field.

Sl. No.	Programme	Eligibility for Admission in M.Tech. / MCA / M.Sc. / M.Com. / MA Programmes
13.	M.Com	B.Com. / BBA
14.	M.A. Islamic Studies	B.A. in Islamic Studies / Arabic (or) Afzal-ul-Ulama (or) Any under graduate degree with Part 1 Arabic (or) Any under graduate degree with Aalim Sanad / Diploma / Certificate in Arabic or Islamic Studies.

#### 4.0. STRUCTURE OF THE PROGRAMME

4.1. The PG. programmes consist of the following components as prescribed in the respective curriculum:

- i. Core courses
- ii. Elective courses
- iii. Laboratory integrated theory courses
- iv. Project work
- v. Laboratory courses
- vi. Open elective courses
- vii. Seminar
- viii. Mini Project
- ix. Industry Internship
- x. MOOC courses (NPTEL- Swayam, Coursera etc.)
- xi. Value added courses

4.1.1. The curriculum and syllabi of all programmes shall be approved by the Academic Council of this Institution.

4.1.2. For the award of the degree, the student has to earn a minimum total credits specified in the curriculum of the respective specialization of the programme.

4.1.3. The curriculum of programmes shall be so designed that the minimum prescribed credits required for the award of the degree shall be within the limits specified below:

<b>Programme</b>	<b>Range of credits</b>
M.Tech.	80 - 86
MCA	80 - 86
M.Sc.	80 - 85
M.Com.	80 - 88
M.A.	80 - 84

**4.1.4.** Credits will be assigned to the courses for all programmes as given below:

- ❖ One credit for one lecture period per week or 15 periods of lecture per semester.
- ❖ One credit for one tutorial period per week or 15 periods per semester.
- ❖ One credit each for seminar/practical session/project of two or three periods per week or 30 periods per semester.
- ❖ One credit for 160 hours of industry internship per semester for all programmes (except M.Com.)
- ❖ Four credits for 160 hours of industry internship per semester for M.Com.

**4.1.5.** The number of credits the student shall enroll in a non-project semester and project semester is as specified below to facilitate implementation of Choice Based Credit System.

<b>Programme</b>	<b>Non-project semester</b>	<b>Project semester</b>
M.Tech.	9 to 32	18 to 26
MCA	9 to 32	18 to 26
M.Sc.	9 to 32	10 to 26
M.Com.	9 to 32	16 to 28
M.A.	9 to 32	NA

**4.1.6** The student may choose a course prescribed in the curriculum from any department offering that course without affecting regular class schedule. The attendance will be maintained course wise only.

**4.1.7** The students shall choose the electives from the curriculum with the approval of the Head of the Department / Dean of School.

**4.1.8** Apart from the various elective courses listed in the curriculum for each specialization of programme, the student can choose a maximum of two

electives from any other similar programmes across departments, alter to open electives, during the entire period of study, with approval of Head of the department offering the course and parent department.

#### **4.1.9. Online courses**

Students are permitted to undergo department approved online courses under SWAYAM up to 40% of credits of courses in a semester excluding project semester (in case of M.Tech. M.Sc. & MCA programmes) with the recommendation of the Head of the Department / Dean of School and with the prior approval of Dean Academic Affairs during his/ her period of study. The credits earned through online courses shall be transferred following the due approval procedures. The online courses can be considered in lieu of core courses and elective courses.

Students shall undergo project related online course on their own with the mentoring of the project supervisor.

### **3.5 Project work**

**3.5.1** Project work shall be carried out by the student under the supervision of a faculty member in the department with similar specialization.

**3.5.2** A student may however, in certain cases, be permitted to work for the project in an Industry / Research organization, with the approval of the Head of the Department/ Dean of School. In such cases, the project work shall be jointly supervised by a faculty of the Department and an Engineer / Scientist / Competent authority from the organization and the student shall be instructed to meet the faculty periodically and to attend the review meetings for evaluating the progress.

**3.5.3** The timeline for submission of final project report / dissertation is within 30 calendar days from the last instructional day of the semester in which project is done.

**3.5.4** If a student does not comply with the submission of project report / dissertation on or before the specified timeline he / she is deemed to have not completed the project work and shall re-register in the subsequent semester.

### **5.0 DURATION OF THE PROGRAMME**

**5.1.** The minimum and maximum period for completion of the programmes are

given below:

<b>Programme</b>	<b>Min. No. of Semesters</b>	<b>Max. No. of Semesters</b>
M.Tech.	4	8
MCA	4	8
M.Sc.	4	8
M.Com.	4	8
M.A.	4	8

**5.2** Each academic semester shall normally comprise of 90 working days. Semester end examinations shall follow within 10 days of the last Instructional day.

**5.3** Medium of instruction, examinations and project report shall be in English.

## **6.0 REGISTRATION AND ENROLLMENT**

**6.1** The students of first semester shall register and enroll at the time of admission by paying the prescribed fees. For the subsequent semesters registration for the courses shall be done by the student one week before the last working day of the previous semester.

### **6.2 Change of a Elective Course**

A student can change an enrolled elective course within 10 working days from the commencement of the course, with the approval of the Dean (Academic Affairs), on the recommendation of the Head of the Department of the student.

### **6.3 Withdrawal from a Course**

A student can withdraw from an enrolled course at any time before the first continuous assessment test for genuine reasons, with the approval of the Dean (Academic Affairs), on the recommendation of the Head of the Department of the student.

**6.4** A student can enroll for a maximum of 36 credits during a semester including Redo / Predo courses.

## **7.0 BREAK OF STUDY FROM PROGRAMME**

**7.1** A student may be allowed / enforced to take a break of study for two

semesters from the programme with the approval of Dean (Academic Affairs) for the following reasons:

7.1.1 Medical or other valid grounds

7.1.2 Award of 'I' grade in all the courses in a semester due to lack of attendance

7.1.3 Debarred due to any act of indiscipline

**7.2** The total duration for completion of the programme shall not exceed the prescribed maximum number of semesters (vide clause 3.1).

**7.3** A student who has availed a break of study in the current semester (odd/even) can rejoin only in the subsequent corresponding (odd/even) semester in the next academic year on approval from the Dean (Academic affairs).

**7.4** During the break of study, the student shall not be allowed to attend any regular classes or participate in any activities of the Institution. However, he / she shall be permitted to enroll for the 'I' grade courses and appear for the arrear examinations.

## **8.0 CLASS ADVISOR AND FACULTY ADVISOR**

### **8.1 CLASS ADVISOR**

A faculty member shall be nominated by the HOD/ Dean of School as Class Advisor for the class throughout their period of study.

The class advisor shall be responsible for maintaining the academic, curricular and co-curricular records of students of the class throughout their period of study.

### **8.2 FACULTY ADVISOR**

To help the students in planning their courses of study and for general counseling, the Head of the Department / Dean of School of the students shall attach a maximum of 20 students to a faculty member of the department who shall function as faculty advisor for the students throughout their period of study. Such faculty advisor shall guide the students in taking up the elective courses for registration and enrolment in every semester and also offer advice to the students on academic and related personal matters.

**9.0 COURSE COMMITTEE**

**9.1** Each common theory / laboratory course offered to more than one group of students shall have a "Course Committee" comprising all the teachers handling the common course with one of them nominated as course coordinator. The nomination of the course coordinator shall be made by the Head of the Department / Dean (Academic Affairs) depending upon whether all the teachers handling the common course belong to a single department or from several departments. The Course Committee shall meet as often as possible to prepare a common question paper, scheme of evaluation and ensure uniform evaluation of the assessment tests and semester end examination.

**10.0 CLASS COMMITTEE**

**10.1** A class committee comprising faculty members handling the courses, student representatives and a senior faculty member not handling any courses for that class as chairman will be constituted in every semester:

**10.2** The composition of the class committee will be as follows:

- i) One senior faculty member preferably not handling courses for the concerned semester, appointed as chairman by the Head of the Department
- ii) Faculty members of all courses of the semester
- iii) All the students of the class
- iv) Faculty advisor and class advisor
- v) Head of the Department – Ex officio member

**10.3** The class committee shall meet at least three times during the semester. The first meeting shall be held within two weeks from the date of commencement of classes, in which the nature of continuous assessment for various courses and the weightages for each component of assessment shall be decided for the first and second assessment. The second meeting shall be held within a week after the date of first assessment report, to review the students' performance and for follow up action.

**10.4** During these two meetings the student members, shall meaningfully interact and express opinions and suggestions to improve the

effectiveness of the teaching-learning process, curriculum and syllabi of courses.

- 10.5** The third meeting of the class committee, excluding the student members, shall meet within 5 days from the last day of the semester end examination to analyze the performance of the students in all the components of assessments and decide their grades in each course. The grades for a common course shall be decided by the concerned course committee and shall be presented to the class committee(s) by the concerned course coordinator.

### **11.0 CREDIT REQUIREMENTS TO REGISTER FOR PROJECT WORK**

- 11.1** A student is permitted to register for project semester, if he/she has earned the minimum number of credits specified below:

<b>Programme</b>	<b>Minimum no. of credits to be earned to enroll for project semester</b>
M.Tech.	18
MCA	22
M.Sc.	18
M.Com	NA
M.A.	NA

- 11.2** If the student has not earned minimum number of credits specified, he/she has to earn the required credits, at least to the extent of minimum credits specified in clause 9.1 and then register for the project semester.

### **12.0 ASSESSMENT PROCEDURE AND PERCENTAGE WEIGHTAGE OF MARKS**

- 12.1** Every theory course shall have a total of three assessments during a semester as given below:

<b>Assessments</b>	<b>Weightage of Marks</b>
Continuous Assessment 1	25%
Continuous Assessment 2	25%
Semester End Examination	50%

## 12.2 Theory Course

Appearing for semester end theory examination for each course is mandatory and a student shall secure a minimum of 40% marks in each course in semester end examination for the successful completion of the course.

## 12.3 Laboratory Course

Every practical course shall have 75% weightage for continuous assessments and 25% for semester end examination. However, a student shall have secured a minimum of 50% marks in the semester end practical examination for the award of pass grade.

## 12.4 Laboratory Integrated Theory (LIT) Courses

For laboratory integrated theory courses, the theory and practical components shall be assessed separately for 100 marks each and consolidated by assigning a weightage of 75% for theory component and 25% for practical component (for a 4 credit LIT Course). Grading shall be done for this consolidated mark. Assessment of theory components shall have a total of three assessments with two continuous assessments carrying 25% weightage each and semester end examination carrying 50% weightage. The student shall secure a separate minimum of 40% in the semester end theory examination. The evaluation of practical components shall be through continuous assessment.

Component	Maximum Marks	Weightage for Final Grade	Mode of Assessment
Theory Component	100	75%	CAT1 (25%) + CAT2 (25%) + SEE (50%)
Practical Component	100	25%	Continuous assessment only
Final Grade Basis	Consolidated	100%	75% Theory + 25% Practical
Pass Requirement	-	-	Minimum 40% in Semester-End Theory Exam (SEE)

**Note:**

1. Proportionate weightage shall be assigned to LIT courses based on their credit value, whether 2 or 3 credits.
2. In Lab-Integrated Professional Elective courses, the laboratory component shall be assessed by the course faculty.

**12.5** The components of continuous assessment for theory/practical/laboratory integrated theory courses shall be finalized in the first class committee meeting.

**12.6 Industry Internship**

In the case of industry internship, the student shall submit a report, which shall be evaluated along with an oral examination by a committee of faculty members constituted by the Head of the Department. The student shall also submit an internship completion certificate issued by the industry / research / academic organisation. The weightage of marks for industry internship report and viva voce examination shall be 60% and 40% respectively.

**12.7 Project Work**

**Mini project work**, shall be carried out individually or as a group activity involving a maximum of three students.

Each group shall identify a suitable topic within their domain, either disciplinary or interdisciplinary, based on the students' abilities and in consultation with the faculty mentor. The topic must lead to the development of a small-scale system or application.

The progress of the mini project shall be evaluated through three periodic reviews: two interim reviews and one final review. A project report shall be submitted by the end of the semester. The reviews shall be conducted by a committee of faculty members constituted by the Head of the Department / Dean of the School.

An oral examination (viva voce) shall be conducted as the semester-end examination by an internal examiner approved by the Controller of Examinations, based on the project report.

The weightage for assessment shall be as follows:

- Periodic Reviews: 50%
  - 25% by the Project Guide
  - 25% by the Review Committee

- Project Report: 20%
- Viva Voce Examination: 30%

**The Project** shall be carried out individually or as a group activity, involving a maximum of two or three students.

A committee of faculty members, constituted by the Head of the Department / Dean of the School, shall conduct three periodic reviews during the semester to monitor and assess the progress of the project.

At the end of the semester, students shall submit a project report, based on which a semester-end oral examination (viva voce) shall be conducted by an external examiner approved by the Controller of Examinations.

The assessment weightage shall be as follows:

- Periodic Reviews – 50%
  - 25% by the Project Guide
  - 25% by the Review Committee
- Project Report – 20%
- Viva Voce Examination – 30%

**12.8** The assessment of seminar course including its component and its weightage shall be decided by a committee of faculty members constituted by the Head of the Department. This committee shall ensure the conduct of assessment of components and award marks accordingly.

**12.9** For the first attempt of the arrear theory examination, the internal assessment marks scored for a course during first appearance shall be used for grading along with the marks scored in the arrear examination. From the subsequent appearance onwards, full weightage shall be assigned to the marks scored in the semester end examination and the internal assessment marks secured during the course of study shall become invalid.

**In case of laboratory integrated theory courses**, after one regular and one arrear appearance, the internal mark of theory component is invalid and full weightage shall be assigned to the marks scored in the semester end examination for theory component. **There shall be no arrear or improvement examination for lab components.**

**13.0 SUBSTITUTE EXAMINATIONS**

- 13.1** A student who is absent, for genuine reasons, may be permitted to write a substitute examination for any one of the two continuous assessment tests of a course by paying the prescribed substitute examination fee. However, permission to take up a substitute examination will be given under exceptional circumstances, such as accidents, admission to a hospital due to illness, etc. by a committee constituted by the Head of the Department / Dean of School for that purpose. However, there is no substitute examination for semester end examination.
- 13.2** A student shall apply for substitute exam in the prescribed form to the Head of the Department / Dean of School within a week from the date of assessment test. However, the substitute examination will be conducted only after the last working day of the semester and before the semester end examination.

**14.0 ATTENDANCE REQUIREMENT AND SEMESTER / COURSE REPETITION**

- 14.1** A student shall earn 100% attendance in the scheduled contact hours (such as lectures, tutorials, labs, etc.) for that course. However, a relaxation of up to 25% in attendance may be granted to account for valid reasons such as medical emergencies, participation in co-curricular or extracurricular activities with prior approval, or other genuine circumstances.
- If a student's attendance falls below 75% in a particular course, even after considering the permissible relaxation, they will not be allowed to appear for the semester-end examination in that course. Instead, the student will be awarded an "I" grade (Incomplete) for the course
- 14.2** The faculty member of each course shall cumulate the attendance details for the semester and furnish the names of the students who have not earned the required attendance in the concerned course to the class advisor. The class advisor shall consolidate and furnish the list of students who have earned less than 75% attendance, in various courses, to the Dean (Academic Affairs) through the Head of the Department / Dean of the School. Thereupon, the Dean (Academic Affairs) shall officially notify the names of such students prevented from writing the semester end

examination in each course.

- 14.3** If a student's attendance in any course falls between 65% and 75% due to medical reasons (e.g., hospitalization, illness) or participation in institution-approved events, they may be granted exemption from the minimum attendance requirement and allowed to appear for the semester-end exam. The student must submit valid documents to the class advisor upon rejoining, with approval from the HoD/Dean. Final approval for **condonation** will be granted by the Vice Chancellor based on the Dean (Academic Affairs)'s recommendation.
- 14.4** A student who has obtained an "I" grade in all the courses in a semester is not permitted to move to the next higher semester. Such students shall **repeat** all the courses of the semester in the subsequent academic year. However, he / she is permitted to redo the courses awarded with 'I' grade / arrear in previous semesters. They shall also be permitted to write arrear examinations by paying the prescribed fee.
- 14.5** The student awarded "I" grade, shall enroll and repeat the course when it is offered next. In case of "I" grade in an elective course either the same elective course may be repeated or a new elective course may be taken with the approval of the Head of the Department / Dean of the School.
- 14.6** A student who is awarded "U" grade in a course shall have the option to either write the semester end arrear examination at the end of the subsequent semesters, or to **redo** the course when the course is offered by the department. Marks scored in the continuous assessment in the redo course shall be considered for grading along with the marks scored in the semester end (redo) examination. If any student obtains "U" grade in the redo course, the marks scored in the continuous assessment test (redo) for that course shall be considered as internal mark for further appearance of arrear examination.
- 14.7** If a student with "U" grade, who **prefers to redo** any particular course, fails to earn the minimum 75% attendance while doing that course, then he / she is not permitted to write the semester end examination and his / her earlier "U" grade and continuous assessment marks shall continue.

**15.0 REDO / PRE-DO COURSES**

- 15.1** A student can register for a maximum of three redo courses per semester without affecting the regular semester classes, whenever such courses are offered by the concerned department, based on the availability of faculty members and subject to a specified minimum number of students registering for each of such courses.
- 15.2** The number of contact hours and the assessment procedure for any redo course shall be the same as regular courses, except there is **no provision for any substitute examination and withdrawal from a redo course.**
- 15.3** A student shall be permitted to pre-do a course offered by the concerned department, provided it does not affect the regular semester class schedule. Such permission shall be granted based on the availability of faculty members, the maximum permissible credit limit of the semester, and the student's fulfillment of the necessary prerequisites for the course. The proposal shall be recommended by the Dean of the School and the Head of the Department, and shall require final approval from the Dean (Academic Affairs).

**16.0 PASSING AND DECLARATION OF RESULTS AND GRADE SHEET**

- 16.1** All assessments of a course shall be made on absolute marks basis. The class committee without the student members shall meet to analyse the performance of students in all assessments of a course and award letter grades following the relative grading system. The letter grades and the corresponding grade points are as follows:

<b>Letter Grade</b>	<b>Grade Points</b>
S	10
A	9
B	8
C	7
D	6
E	5
U	0
W	-

I	-
PA	-
FA	-

**"W"** - denotes withdrawal from the course

**"I"** - denotes "Incomplete" ie. inadequate attendance in the course and prevention from appearance of semester end examination

**"U"** - denotes unsuccessful performance in the course.

**"PA"** - denotes the 'Pass' of the zero credit courses.

**"FA"** - denotes the 'Fail' of the zero credit courses.

**16.2** A student who earns a minimum of five grade points ('E' grade) in a course is declared to have successfully completed the course. Such a course cannot be **repeated by the student for improvement of grade**.

**16.3** Upon awarding grades, the results shall be endorsed by the chairman of the class committee and Head of the Department / Dean of the School. The Controller of Examinations shall further approve and declare the results.

**16.4 Within one week** from the date of declaration of result, a student can apply for revaluation of his / her semester end theory examination answer scripts of one or more courses, on payment of prescribed fee, through proper application to the Controller of Examinations. Subsequently, the Head of the Department / Dean of the School offered the course shall constitute a revaluation committee consisting of chairman of the class committee as convener, the faculty member of the course and a senior faculty member having expertise in that course as members. The committee shall meet within a week to revalue the answer scripts and submit its report to the Controller of Examinations for consideration and decision.

**16.5** After results are declared, grade sheets shall be issued to each student, which contains the following details: a) list of courses enrolled during the semester including redo courses / arrear courses, if any; b) grades scored; c) Grade Point Average (GPA) for the semester and d) Cumulative Grade Point Average (CGPA) of all courses enrolled from the

first semester onwards.

GPA is the ratio of the sum of the products of the number of credits of courses registered and the grade points corresponding to the grades scored in those courses, taken for all the courses, to the sum of the number of credits of all the courses in the semester.

If  $C_i$ , is the number of credits assigned for the  $i^{\text{th}}$  course and  $GP_i$  is the

$$GPA = \frac{\sum_{i=1}^n (C_i)(GP_i)}{\sum_{i=1}^n C_i}$$

Grade Point in the  $i^{\text{th}}$  course,

Where  $n$  = number of courses

The Cumulative Grade Point Average (CGPA) is calculated in a similar manner, considering all the courses enrolled from first semester.

“I”, “W”, “PA” and “FA” grades are excluded for calculating GPA.

“U”, “I”, “W”, “PA” and “FA” grades are excluded for calculating CGPA.

The formula for the conversion of CGPA to equivalent percentage of marks shall be as follows:

Percentage equivalent of marks = CGPA X 10

**16.6** After successful completion of the programme, the degree shall be awarded to the students with the following classifications based on CGPA.

Classification	CGPA
First Class with Distinction	8.50 and above and passing all the courses in first appearance and completing the programme within the prescribed period of 8 semesters for all students (except lateral entry students) and 6 semesters for lateral entry students
First Class	6.50 and above and completing the programme within a maximum of 10 semesters for all students (except lateral entry students) and 8 semesters for lateral entry students
Second Class	Others

**16.6.1 Eligibility for First Class with Distinction**

- A student should not have obtained 'U' or 'I' grade in any course during his/her study
- A student should have completed the UG programme within the minimum prescribed period of study (except clause 7.1.1)

**16.6.2 Eligibility for First Class**

- A student should have passed the examination in all the courses not more than two semesters beyond the minimum prescribed period of study (except clause 7.1.1)

**16.6.3** The students who do not satisfy clause 16.6.1 and clause 16.6.2 shall be classified as second class.

**16.6.4** The CGPA shall be rounded to two decimal places for the purpose of classification. The CGPA shall be considered up to three decimal places for the purpose of comparison of performance of students and ranking.

**17.0 SUPPLEMENTARY EXAMINATION**

**Final year students and passed out students** can apply for supplementary examination for a maximum of **three** courses thus providing an opportunity to complete their degree programme. Likewise, students with less credit can also apply for supplementary examination for a maximum of **three** courses to enable them to earn minimum credits to move to higher semester. The students can apply for supplementary examination within three weeks of the declaration of results in both odd and even semesters.

**18.0 DISCIPLINE**

**18.1** Every student is expected to observe discipline and decorum both inside and outside the campus and not to indulge in any activity which tends to affect the reputation of the Institution.

**18.2** Any act of indiscipline of a student, reported to the Dean (Student Affairs), through the Head of the Department / Dean of the School concerned shall be referred to a Discipline and Welfare Committee constituted by the Registrar for taking appropriate action.

## 19.0 MULTI ENTRY AND MULTI EXIT (MEME) FRAMEWORK \*

In accordance with the provisions of the National Education Policy (NEP) 2020, the programme shall support a Multi Entry – Multi Exit (ME-ME) framework to provide flexibility in the academic pathway of students.

\* **At present (AY 2025-26), it is applicable only for all M.Tech. Programmes.**

### 19.1. Exit Option:

#### 19.1.1 Credit Requirement for Award of M.Tech. Degree

To qualify for the award of a M.Tech. degree from the Institute, a student must successfully complete the total credit requirements as prescribed in the approved curriculum of the respective programme. The specific credit requirements are determined by the programme curriculum.

#### 19.1.2 Provision for Multiple Exit

In alignment with NEP 2020 guidelines, the Institute provides students enrolled in postgraduate programmes with the option of multiple exits, subject to the following conditions:

##### a. Exit at the End of First Year

Students may choose to exit the programme at the end of the first year, provided they have fulfilled the prescribed academic requirements.

##### b. Application for Exit

A student intending to exit must submit a formal written application in the prescribed format at least **eight weeks prior to the scheduled end of the academic year.**

##### c. Departmental Recommendation

1. Upon receipt of the application, the concerned Department shall evaluate the academic record of the student and recommend the award of a **Post Graduate Diploma**, based on the credits earned.

2. In the case of arrear courses, the post graduate diploma will be conferred only after successful clearance of all pending arrears.

##### d. Notification of Completion

Once a student has fulfilled the requirements for the award of post graduate diploma, the Department shall notify the same to controller of

examinations for further processing and issuance.

### 19.1.3 Award of Qualifications under Multiple Exit Scheme

Post graduate diploma: Awarded after successful completion of the first year, subject to earning the prescribed cumulative credits as per the respective programme curriculum (e.g., 44 credits from the first year) along with 3 credits of Skill Based Courses.

### 19.1.4 Conditions Governing Exit

1. The multiple exit facility is intended strictly for **genuine and exceptional circumstances**, such as prolonged illness, or securing an employment opportunity necessitating a temporary withdrawal from the programme.
2. Students opting for a temporary exit after the first year must obtain **prior approval from the Registrar through Dean (Academics)**, based on the recommendation of the respective Head of the Department.

### 19.1.5 Expectation of Programme Continuity

While the option for multiple exits exists, it is generally expected that students admitted to a post graduate programme shall pursue their studies continuously until completion of the final degree requirements.

### 19.2. Entry Option:

Students seeking re-entry into the programme (multi-entry) must submit an application through the proper channel at the beginning of the odd semester. Admission shall be subject to fulfilment of institutional guidelines, credit mapping, and availability of seats.

### 19.3. Credits Requirement for the Certifications

Name of the Certificate Programme	Required Credits
Post graduate Diploma (Level 6.5 as per NEP 2020)	40* - 45

\* The minimum number of credits that a student must earn (as per the respective curriculum) in order to get the above certification program

## 20.0 ELIGIBILITY FOR THE AWARD OF THE MASTER'S DEGREE

**20.1** A student shall be declared to be eligible for the award of the Master's Degree, if he/she has:

- i. Successfully acquired the required credits as specified in the

curriculum corresponding to his/her programme within the maximum period of 8 semesters from the date of admission, including break of study.

- ii. No disciplinary action is pending against him/her.
- iii. Enrolled and completed at least one value added course.
- iv. Enrollment in at least one MOOC / SWAYAM course (non-credit) before the final semester.

**20.2** The award of the degree must have been approved by the Institute.

### **21.0 POWER TO MODIFY**

Not with standing all that have been stated above, the Academic Council has the right to modify any of the above regulations from time to time.

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**B.S. ABDUR RAHMAN CRESCENT INSTITUTE OF SCIENCE AND TECHNOLOGY**  
**REGULATIONS 2025**  
**CURRICULUM & SYLLABI FOR**  
**M.SC. PHYSICS**

**SEMESTER I**

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
1.	PCC	PHF 6101	Classical Mechanics	3	1	0	4
2.	PCC	PHF 6102	Mathematical Physics	3	1	0	4
3.	PCC	PHF 6103	Condensed Matter Physics	3	1	0	4
4.	PCC	PHF 6104	Materials Science Laboratory	0	0	4	2
5.	PEC	PHFY 1XX	Elective I	3	0	0	3
6.	PEC	PHFY 1XX	Elective II	3	0	0	3
<b>Credits</b>							<b>20</b>

**SEMESTER II**

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
1.	PCC	PHF 6201	Electrodynamics	3	1	0	4
2.	PCC	PHF 6202	Quantum Mechanics	3	1	0	4
3.	PCC	PHF 6203	Advanced Electronics And Instrumentation	4	0	0	4
4.	PEC	PHF 6204	Advanced Electronics Laboratory	0	0	4	2
5.	ES	GEF 6202	Research Methodology and IPR	3	1	0	4
6.	PEC	PHFY 2XX	Elective III	3	0	0	3
7.	HS	ENF 6281	Professional Communication	0	0	2	1
8.	Project	PHF 6205	Mini Project	0	0	6	2
9.		----	MOOC Course	-	-	-	-
<b>Credits</b>							<b>24</b>

**SEMESTER III**

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
1.	PCC	PHF 7101	Atomic and Molecular Spectroscopy	4	0	0	4
2.	PCC	PHF 7102	Nuclear and Particle Physics	4	0	0	4
3.	PCC	PHF 7103	Thermodynamics and Statistical Physics	4	0	0	4
4.	PCC	PHF 7104	Optics and Thermal Laboratory	0	0	4	2
5.	PEC	PHFY 3XX	Elective IV	3	0	0	3
6.	PEC	PHFY 3XX	Elective V	3	0	0	3
7.	OEC	OEFY XXX	Open Elective Course	3	0	0	3
8.	Internship	PHF 7105	Industry Internship	0	0	4	2
9.	Project	PHF 7201	Project Phase I	0	0	8	4**
<b>Credits</b>							<b>25</b>

**SEMESTER IV**

Sl. No.	Course Group	Course Code	Course Title	L	T	P	C
1.	Project	PHF 7201	Project Phase – II	0	0	34	10
<b>Credits</b>							<b>(10+4=14)</b>

**Overall Total Credits – 84**

\* # Industrial training will be undertaken during first year summer vacation for 30 days. The credit will be awarded in the 3rd Semester.

\* \*\* Credits for project work phase I in III semester to be accounted along with project work phase II in IV semester

**LIST OF ELECTIVES**

Sl. No.	Course Code	Course Title	L	T	P	C
<b>SEMESTER I</b>						
1	PHFY 101	Crystal Growth and Characterization	2	0	1	3
2	PHFY 102	Functional Materials and its Applications	3	0	0	3
3	PHFY 103	<b>*Laser and Non-linear optics</b>	3	0	0	3
4	PHFY 104	Materials Characterization	3	0	0	3
5.	PHFY 105	Nanoscience and Technology	3	0	0	3
6.	PHFY 106	Optical Fiber Communication	2	0	1	3
<b>SEMESTER II</b>						
1.	PHFY 201	Ferroelectric Materials and Devices	3	0	0	3
2.	PHFY 202	Introduction to Nonlinear Dynamics	3	0	0	3
3.	PHFY 203	Numerical Methods and Programming	3	0	0	3
4.	PHFY 204	Nanophotonic Devices and Applications	3	0	0	3
5.	PHFY 205	Optical Modulators and Devices	3	0	0	3
6.	PHFY 206	Optoelectronic Devices	2	0	1	3
7.	PHFY 207	Photonic Materials and Devices	3	0	0	3
8.	PHFY 208	Advanced Non-Destructive Testing	3	0	0	3
<b>SEMESTER III</b>						
1	PHFY 301	Advanced Materials for Energy Applications	3	0	0	3
2	PHFY 302	Biomaterials	3	0	0	3
3	PHFY 303	Biomedical Instrumentation	3	0	0	3
4	PHFY 304	Corrosion Science and Technology	3	0	0	3
5	PHFY 305	Density Functional Theory	3	0	0	3
6	PHFY 306	Introduction to Quantum Computing	3	0	0	3
7	PHFY 307	Measurements and Instrumentation	3	0	0	3
8	PHFY 308	Radiation Physics	3	0	0	3
9	PHFY 309	Solitons in Nonlinear Optics	3	0	0	3
10	PHFY 310	Thin film science and Technology	3	0	0	3

\*Mandatory Elective for Semester - I

<b>PHF 6101</b>	<b>CLASSICAL MECHANICS</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>SDG: 04</b>		<b>3</b>	<b>1</b>	<b>0</b>	<b>4</b>

**COURSE OBJECTIVES:**

COB1: To provide the foundations of the advanced level mechanics

COB2: To learn Lagrangian and Hamiltonian mechanics

COB3: To understand Rigid body dynamics and small oscillations

COB4: To explore the central force and nonlinear systems

COB5: To acquire the knowledge related to Relativistic Mechanics

**MODULE I LAGRANGIAN FORMULATION L: 9 T:3 P: 0**

Mechanics of a system of particles. Constraints - Generalized coordinates, D'Alembert's principle and Lagrange's equations of motion - Velocity dependent potentials and dissipation function - Applications of Lagrangian formulation. Hamilton's (variational) principle and derivation of Lagrange's equations - shortest distance and Brachistochrone - Generalized momenta and energy - conservation laws and cyclic coordinates: Simple applications of the Lagrangian formulation: L-C circuit – Linear harmonic oscillator and Atwood's machine.

**MODULE II CENTRAL FORCE MOTION AND RIGID BODY DYNAMICS L: 9 T:3 P: 0**

Central force motion: General features - The Kepler problem: inverse square law force - Two body Collisions and Centre of mass frames - Scattering in a central force field. Rigid body dynamics: moment of inertia tensor - Euler angles - Euler's equations of motion - Heavy symmetrical top.

**MODULE III HAMILTONIAN FORMULATION L:9 T:3 P: 0**

Dynamical systems - Phase-space dynamics -Legendre transformation - Hamiltonian and Hamilton's equation of motion - Hamilton's equations from variational principle - Liouville's theorem - Canonical transformation and Poisson brackets. Hamilton-Jacobi equation for Hamilton's principle function - Hamilton's characteristic function - Application (Harmonic oscillator) - Separation of variables - Action angle variables.

**MODULE IV LINEAR AND NONLINEAR OSCILLATIONS L:9 T:3 P: 0**

Theory of small oscillations – Frequencies of free vibration and normal coordinates – Two coupled harmonic oscillators – Vibrations of a linear triatomic molecule. Classical

Field Theory - Lagrangian and Hamiltonian formalisms for continuous system. Nonlinear dynamical systems: Mathematical implications of nonlinearity – Linear vs Nonlinear oscillators – Linear stability analysis - Classification of equilibrium points – Duffing Oscillator — ordered and chaotic dynamics – initial conditions – Linear and Nonlinear waves – solitons.

#### **MODULE V THEORY OF RELATIVITY**

**L:9 T:3 P: 0**

Reviews of basic ideas of special relativity - Inertial and non-inertial reference frames – Addition of velocities, mass, energy – variation of mass with velocity -- Mass-Energy equivalence – Pseudo forces – Galilean and Lorentz transformations – Invariance of Maxwell's equations under Lorentz transformation – Lagrangian and Hamiltonian of relativistic particles. Elements of general theory of relativity.

**L – 45; T – 15; P – 0; Total Hours: 60**

#### **TEXT BOOKS:**

1. Golstein. H, Poole. C and Sofko. J, Classical Mecanics , Pearson Education, New Delhi, 2014.
2. B. D. Gupta and Satya Prakash, Classical Mechanics, Keder Nath Ram Nath Publishers, Meerut, 2020.
3. Rana. N.C and Joag.P.S, Classical Mechanics, Tata Mc-Graw Hill Publishing Company Limited, New Delhi, 2017.
4. Upadhyaya. J.C., Classical Mechanics, Himalaya Publishing House, 2019.

#### **REFERENCES:**

1. M.Lakshmanan and S.Rajasekar, Nonlinear dynamics: Integrability, Chaos and Spatio-temporal patterns, Springer-Verlag, 2003.
2. Classical Dynamics, A contemporary Approach, Jorge V Jose, E J Saletan , Cambridge University Press, 2002.
3. Marion and Thorntroon, Classical Dynamics of Particles and Systems, Fifth Edition, Holt Rinehart & Winston, 2012.
4. Panat. P.V, Classical Mechanics, Narosa Publishing Home, New Delhi, 2008.

#### **COURSE OUTCOMES:**

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

**CO1:** gain the knowledge on advanced level mechanics.

**CO2:** comprehend the basics of Lagrange's equation and Hamiltonian equation for a system of particles

- CO3:** compare and discuss the principles of central force problem
- CO4:** get insights into dynamics of Rigid body and small oscillations
- CO5:** understand the principles of relativistic mechanics and Nonlinear systems

**Board of Studies (BoS):**

15<sup>th</sup> BoS of Physics Department held on  
18/07/2025

**Academic Council:**

24<sup>th</sup> AC held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	M	L	L	H	L	L	L	H	H	M
CO2	M	M	L	L	L	H	M	M	H	H
CO3	M	L	H	L	L	L	L	M	H	M
CO4	L	M	M	H	H	L	L	M	H	H
CO5	L	L	L	L	L	L	L	H	M	H

\* Legend: L – Low (1), M – Medium (2), H – High (3).

**SDG 4:** Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

**Statement:**

The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and promote learning opportunities at all times.

<b>PHF 6102</b>	<b>MATHEMATICAL PHYSICS</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>SDG: 4</b>		<b>3</b>	<b>1</b>	<b>0</b>	<b>4</b>

**COURSE OBJECTIVES:**

- COB1:** To provide a strong mathematical foundation in vector calculus, matrices.
- COB2:** To understand complex variables.
- COB3:** To discuss the properties of differential equations and special functions.
- COB4:** To learn about Fourier transform and Greens functions.
- COB5:** To familiarize the basics of Tensor analysis and Group theory

**MODULE I VECTORS AND MATRICES L:9 T:3 P:0**

Vector analysis: Gradient – Divergence – Curl – vector spaces – linear dependence and independence of vectors - second order derivatives Gauss's theorem - Stoke's theorem - Green's theorem – Curvilinear coordinates spherical polar-cylindrical coordinates. Matrices: Orthogonal and Unitary Matrices, Matrix diagonalization, Cayley-Hamilton theorem - eigen values and eigen vectors.

**MODULE II COMPLEX VARIABLES L:9 T:3 P:0**

Functions of complex variables – single and many valued functions-analytic functions – Cauchy – Riemann equations –conjugate functions – complex line integrals-Cauchy's integral theorem-integral formula – Taylor and Laurent expansions –zeros and singularities – residues –Cauchy's Residue theorem and its applications for evaluation of integrals.

**MODULE III DIFFERENTIAL EQUATIONS AND SPECIAL FUNCTIONS L:9 T:3 P:0**

Linear differential equation of first order and its solution-Solution of Second order differential equation with constant coefficients- Singular points of differential equations-Self adjoint differential equation-Power series solution Frobenius' method- Discrete Differential Equations: Homogeneous and non-homogeneous forms, Z-transform methods - Fractional Discrete Differential Equations: Basics of fractional difference calculus - Definitions: Grünwald–Letnikov, Caputo fractional differences - Linear fractional difference equations. Hermite, Legendre, Bessel and Laguerre differential equations –series solutions- generating functions-

recurrence relations- Sturm Liouville theorem - Orthogonality of eigen function.  
Hyper geometric functions – generating functions.

#### **MODULE IV FOURIER TRANSFORM AND GREEN L:9 T:3 P:0 FUNCTIONS**

Fourier Transform: Fourier transform – sine and cosine transform – properties  
Faultung's theorem- application in heat conduction and spectroscopy. Laplace  
transforms – Inverse transforms – Linearity and Shifting theorems. Linear spaces –  
Basis-change of basis – Inner product space – Schmidt's orthogonalisation  
procedure – Schwartz's inequality – Hilbert spaces - properties. Green's function:  
Definition and construction – symmetry properties - expression for Green's  
functions in terms of Eigen functions - Green's functions for simple and second  
order operator.

#### **MODULE V TENSORS AND GROUP THEORY L:9 T:3 P:0**

Tensor analysis: Cartesian tensors – law of transformation of first and second order  
tensors- addition, subtraction and multiplication (inner and outer product) of tensors  
– Kronecker delta symbol -rank, covariant, contravariant and mixed tensors-  
symmetric and antisymmetric tensors-Quotient law - Invariant tensors -Levi-Civita  
Symbol. Group Theory: Basic definitions subgroups- permutation groups-Cyclic  
groups - cosets - Normal Subgroups Isomorphism - Homomorphism-Rotation  
groups - Reducible – Irreducible representations – Applications.

**L – 45; T – 15; Total Hours: 60**

#### **TEXT BOOKS:**

1. G.B. Arfken, H.J.Weber and F.E. Harris, Mathematical Methods for Physicists, Seventh Edition, Academic Press, 2012.
2. Gupta. B. D., Mathematical Physics, 4th edition, Vikas Publishing House Pvt Limited, 2007.
3. S. Andrilli and D. Hecker, Elementary Linear Algebra, Academic Press, 2006.

#### **REFERENCES:**

1. Erwin Kreyszig, Advanced Engineering Mathematics, 10<sup>th</sup> edition, Wiley, 2015.
2. Paul Blanchard Robert L. Devaney Glen R. Hall, Differential Equations, Brooks/Cole, 2012.
3. Chattopadhyay. P.K, Mathematical Physics, 3rd Edition, New Academic Science,2014.

4. Joshi. A. W, Matrices and Tensors in Physics, 3rd edition, Wiley Eastern Ltd., New Delhi, 1995.
5. Gupta. B. D., Mathematical Physics, 4th edition, Vikas Publishing House Pvt Limited, 2007.
6. Murray Spiegel, Schaum's Outline of Advanced Mathematics for Engineers and Scientists, Schaum's Outline Series, McGraw-Hill, 2009.

### COURSE OUTCOMES:

- CO1:** understand the vector, vector fields, matrices and their need in science.
- CO2:** solve problems in complex variables.
- CO3:** apply knowledge in solving differential equations and special functions.
- CO4:** analyze the importance of Fourier transforms and green's functions.
- CO5:** develop the essential mathematical skills to solve problems in tensors and group theory.

### Board of Studies (BoS):

15<sup>th</sup> BoS of Physics Department held  
on 18/07/2025

### Academic Council:

24<sup>th</sup> AC held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	H	M	L	L	M	M	M	M	H	M
CO2	H	M	M	L	L	L	L	M	M	H
CO3	H	M	M	L	L	M	L	H	M	M
CO4	H	M	M	L	M	M	M	M	H	M
CO5	H	M	M	L	M	M	M	H	H	M

\* Legend: L – Low (1), M – Medium (2), H – High (3).

SDG 4: Ensuring inclusive and equitable quality education for all persons and promote lifelong learning opportunities.

### Statement:

The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and promote learning opportunities at all times.

<b>PHF 6103</b>	<b>CONDENSED MATTER PHYSICS</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>SDG: 4</b>		<b>3</b>	<b>1</b>	<b>0</b>	<b>4</b>

**COURSE OBJECTIVES:**

- COB1:** To introduce crystal structure, band theory and lattice vibrations.
- COB2:** To have comprehensive idea on properties of materials
- COB3:** To provide a sound knowledge of macroscopic properties derived from microscopic considerations
- COB4:** To understand basics of magnetic and dielectric materials
- COB5:** To give an introduction to superconducting and optical materials

**MODULE I CRYSTAL STRUCTURE AND BONDING L:9 T:3 P:0**

General Description of Crystal Structures – Bravais lattices- Wigner Seitz cell- Cubic Structures: NaCl, CsCl, Diamond, Zinc blende - HCP structures— Miller Indices-crystal directions - zones in crystals- interplanar distance (derivation) - The Reciprocal Lattice and its construction-Quasi crystals -Force between atoms-cohesive energy ( derivation)-formation energy- bonding in solids - binding energy of ionic crystals(derivation)-Madelung constant – Born Haber cycle.

**MODULE II TRANSPORT PROPERTIES AND BAND THEORY OF SOLIDS L:9 T:3 P:0**

Classical theory – drawbacks - Free electron theory (Sommerfeld theory) – electrical and thermal conductivity of metals - Wiedemann Franz law (derivation)- Quantum free electron theory - Fermi level-Fermi distribution function -electronic specific heat-electron motion in periodic potential – Bloch's theorem – Kronig Penney model (derivation) - band theory of solids - Brillouin zone - Effective mass of electron and concept of hole- Fermi surface in metals and its characteristics – experimental determination of Fermi surface by De Haas van Alphen effect;

**MODULE III PHONONS : CRYSTAL VIBRATIONS AND THERMAL PROPERTIES L:9 T:3 P:0**

Vibrations of crystals with monoatomic lattice- dispersion relation (derivation) - Vibrations of crystals with diatomic lattice - dispersion relation (derivation)– optical and acoustical modes – number of normal modes of vibrations - Phonon momentum- inelastic scattering of photons by phonons – specific heat of solids-

Einstein theory-Debye's theory of lattice specific heat (derivation) – anharmonic effects.

#### **MODULE IV DIELECTRIC AND OPTICAL PROPERTIES L:9 T:3 P:0**

Dielectric Polarization and polarizability- dielectric constant- types of polarization (qualitative): electronic, ionic, space-charge and orientation polarization, dependence on frequency and temperature-local electric field in an atom- Clausius-Mossotti relation (derivation) – dielectric loss and breakdown - Piezo, pyro and ferroelectric properties of crystals and their applications. Optical properties: Traps – Excitons – coloration of crystals - types of colour centers - Luminescence: fluorescence and phosphorescence.

#### **MODULE V MAGNETISM AND SUPERCONDUCTIVITY L:9 T:3 P:0**

Properties and types of magnetic materials –Diamagnetism – Langevin's theory(derivation)- Paramagnetism – Hund's rules – rare earth ions-iron group ions-crystal field splitting-Pauli paramagnetism- Ferromagnetism –Weiss theory- domain theory - Curie-Weiss law (derivation)- antiferromagnetism – ferrites-applications - Properties of superconductor – critical magnetic field – Meissner effect (derivation) – Type I and Type II superconductors – superfluidity – entropy, heat capacity and energy gap of superconductor-quantum tunneling - London equations (derivation) – coherence length - BCS theory –RVB theory – theory of AC and DC Josephson effect – magnetic levitation - flux quantization- SQUID

**L – 45; T – 15; P – 00; Total Hours: 60**

#### **TEXT BOOKS:**

1. N. Mermin, Neil Ashcroft, Solid State Physics, Brooks/Cole; New edition (2021)
2. Pillai. S.O, Solid State Physics, New Age International, New Delhi, (2009).
3. Gupta Kumar, Solid State Physics, K. Nath & Co. (2018)
4. Ajay Kumar Saxena, Solid State Physics: With An Introduction to Semiconductor Devices, Laxmi Publications; 3<sup>rd</sup> edition (2017)

#### **REFERENCES:**

1. Kittel. C, Introduction to Solid State Physics, 8th edition, Wiley Eastern, New Delhi, 2004.
2. Steven M. Girvin, Modern Condensed Matter Physics, Cambridge University Press (28 February 2019); Cambridge University Press
3. William D. Callister Jr., Materials Science and Engineering: An Introduction, Wiley; 9th edition (4 December 2013)

4. Blakemore. J. S, Solid State Physics, 2nd edition, Cambridge University Press, Cambridge, 1985.
5. Philip Hofmann, Solid State Physics, 1st edition, Wiley-VCH Publishers, 2011.
6. Wahab. A, Solid State Physics: Structure and Properties of Materials , Alpha Science International Ltd; 2<sup>nd</sup> Revised edition,2005

### COURSE OUTCOMES:

- CO1:** to analyse basic concepts on crystal structure, bonding and properties of materials
- CO2:** understand the transport properties and band theory of solids
- CO3:** analyse the concept related to phonon vibrations and thermal properties
- CO4:** compare various types of magnetism and dielectric characteristics in materials
- CO5:** gain knowledge on optical properties of materials and superconductivity.

#### Board of Studies (BoS):

15<sup>th</sup> BoS of Physics Department  
held on 18/07/2025

#### Academic Council:

24<sup>th</sup> AC held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO 3
CO1	H	M	L	L	M	M	M	H	M	H
CO2	H	M	M	L	L	L	L	M	H	H
CO3	H	M	M	L	L	M	L	M	H	M
CO4	H	M	M	L	M	M	M	M	H	H
CO5	H	M	M	L	M	M	M	M	H	H

\* Legend: L – Low (1), M – Medium (2), H – High (3).

**SDG 4:** Ensuring inclusive and equitable quality education for all persons and promote lifelong learning opportunities.

Statement:

The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and promote learning opportunities at all times.

<b>PHF 6104</b>	<b>MATERIALS SCIENCE LABORATORY</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>SDG: 04</b>		<b>0</b>	<b>0</b>	<b>4</b>	<b>2</b>

**COURSE OBJECTIVES:**

- COB1: To gain in-depth knowledge in the field of materials science.
- COB2: To apply the concepts learnt through laboratory in various applications to meet the needs of the society.
- COB3: To make the student familiarize with the basics of experimental physics.
- COB4: To enable the student to explore the concepts involved in the materials related experiments
- COB5: To allow the student to apply the fundamentals of instruments Involved in applications of materials science in materials.

**List of Experiments (Any 12 experiments)**

1. Four Probe experiment: Determination of the Band gap, Conductivity and Resistivity of a given semiconductor at room temperature.
2. Band gap determination using PN junction diode (Forward and Reverse bias).
3. Hall effect experiment: To determine the Hall co-efficient of P and N type semiconductor.
4. Ultrasonic interferometer – Velocity and comparability determination.
5. Hysteresis curve, coercivity, retentivity, saturation magnetization determination of Ferromagnetic substance.
6. Determination of dielectric constant of insulating and ferroelectric materials.
7. I-V characteristics of LEDs.
8. e/m Measurement: Determination of e/m by magnetron method / Thomson method
9. Energy band gap determination of a semiconductor by using UV/photoluminescence spectra.
10. Determination of susceptibility – Quincke's Method.
11. I-V characteristics of solar cell.
12. Geiger Muller Counter: G.M. Counter-Characteristics, Inverse square law & absorption co-efficient
13. Study of the dispersion relation for the mono-atomic and diatomic lattice
14. Determine the thermal conductivity of poor conductor by Lee's disc method.
15. Magnetoresistance of a Semiconductor: To study the magnetic field dependence of the transverse magnetoresistance of a given semiconductor sample.

16. Determination of dielectric Constants of Liquid and solid samples:
17. Crystal growth technique - Solution growth method.
18. Evaluating nonlinear optical properties of a material using Z-scan method.
19. Density Functional Theory – Band structure and Density of states.
20. Preparation of CuO nanoparticles using sol-gel method.
21. Solving differential equations using ODE 45 solver in MATLAB.

**P – 60; TOTAL HOURS – 60**

**COURSE OUTCOMES:**

- CO1:** comprehend the different experimental techniques in materials science.
- CO2:** apply the concepts of Physics principles and interpret them to carry out experiments.
- CO3:** apply the knowledge gained about the experimental techniques in different thermal applications.
- CO4:** comprehend the ideas and principles involved in materials science related experiments
- CO5:** analyse various experimental techniques involving experimental procedures.

**Board of Studies (BoS):**

**Academic Council:**

15<sup>th</sup> BoS of Physics Department held on 18/07/2025

24<sup>th</sup> AC held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	H	M	L	L	M	M	M	M	H	M
CO2	H	M	M	L	L	M	L	M	H	M
CO3	H	M	M	L	L	L	L	H	M	L
CO4	H	M	M	L	M	M	M	H	M	H
CO5	H	M	M	L	M	M	M	M	M	H

\* Legend: L – Low (1), M – Medium (2), H – High (3).

**SDG 4** : Ensuring inclusive and equitable quality education for all persons and promote lifelong learning opportunities.

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**SEMESTER II**

<b>PHF 6201</b>	<b>ELECTRODYNAMICS</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>SDG: 04</b>		<b>3</b>	<b>1</b>	<b>0</b>	<b>4</b>

**COURSE OBJECTIVES:**

- COB1: To understand the fundamental principles of electrostatics and its applications.
- COB2: To gain knowledge on magnetostatics and its applications
- COB3: To apply Maxwell's equations to analyze electromagnetic field behavior and energy conservation.
- COB4: To analyze the propagation of electromagnetic waves based on wave equations and Fresnel's laws
- COB5: To evaluate the invariance of Maxwell's equations under Lorentz transformations and the implications of relativistic electrodynamics

**MODULE I ELECTROSTATICS L:9 T:3 P:0**

Coulomb's law, Gauss's law and applications, Electrostatic potential – Laplace and Poisson's equation – Capacitors – Laplace equation in three dimensions - Boundary value problems and uniqueness theorem, Method of images - Polarization and displacement vectors - Boundary conditions - Dielectric sphere in a uniform field – Molecular polarisability and electrical susceptibility – Electrostatic energy in the presence of dielectric – Multipole expansion.

**MODULE II MAGNETOSTATICS L:9 T:3 P:0**

Biot-Savart Law and its Applications, Ampere's circuital Law – Applications – Magnetic vector and scalar potential - Magnetic moment, force and torque on a current distribution in an external field - Magnetostatic energy - Magnetic induction and magnetic field in macroscopic media - Boundary conditions, Magnetic equivalent of Poisson's equation, inductance, energy density & applications – Effect of a Magnetic field on Atomic orbits – Magnetization – Magnetic susceptibility and permeability.

**MODULE III MAXWELL'S EQUATION L:9 T:3 P:0**

Faraday's laws of Induction - Maxwell's displacement current - Maxwell's equations – free space and linear isotropic media – Boundary conditions on the fields at interfaces -

Vector and scalar potentials - Gauge invariance Coulomb and Lorentz gauges – The Continuity equation Conservation of Energy and momentum of the field - Poynting's theorem - Lorentz force - Conservation laws for a system of charges and electromagnetic fields.

**MODULE ELECTROMAGNETIC WAVES & INTERACTION L:9 T:3 P:0  
IV WITH MATTER**

Wave equation in one dimension, Electromagnetic waves in free space – Dynamics of charged particles in static and uniform electromagnetic fields – Plane waves in non-conducting media - Linear and circular polarization, reflection and refraction at a plane interface-Fresnel's law, interference, coherence and diffraction - Waves in a conducting medium - Propagation in linear media – Reflection and transmission at Normal incidence – Reflection and Transmission at Oblique incidence –Laws of incidence and reflectance, Snell's law, Brewster law – Fresnel's equations – Wave guides and applications, Electromagnetic radiation.

**MODULE V RELATIVISTIC AND QUANTUM L:9 T:3 P:0  
ELECTRODYNAMICS**

Four vectors - Lorentz transformation – invariance of Maxwell's equations under Lorentz transformation - invariance of D'Alembertian operator – invariance of Maxwell's field equations in terms of four vector – Radiation from moving charges and dipoles and retarded potentials - Quantum Electrodynamics (QED) –S-Matrix and its expansion., Feynman graphs, and Feynman rules - Application - Rutherford scattering and Compton scattering

**L – 45; T – 15; P – 0; Total Hours: 60**

**TEXT BOOKS:**

1. David J.Griffith, Introduction to Electrodynamics, 4<sup>th</sup> Edition, Pearson New International Edition, New Delhi, (2014).
2. Satya Prakash, Electromagnetic theory and Electrodynamics, 10<sup>th</sup> edition, Kedar Nath and co., Meerut, (1999).

**REFERENCES:**

1. Joseph A. Edminister, Schaum's Outline of Electromagnetics, McGraw-Hill; Revised edition (1 January 1993)
2. John David Jackson, Classical electrodynamics, 3rd edition, Wiley Eastern Ltd. (1999).

3. Zangwill A, Modern Electrodynamics, 1st edition, Cambridge (2013).
4. Reitz, John R.; Milford, Frederick J., Christy., Robert W., Foundations of Electromagnetic Theory 4<sup>th</sup> ed. Addison Wesley (2008).
5. Capri A.Z. and Panat P.V., Introduction to Electrodynamics, Narosa Publishing House (2010).

### COURSE OUTCOMES:

- CO1:** apply the principles of electrostatics and magnetostatics, and solve problems involving electric and magnetic fields.
- CO2:** solve boundary value problems and analyze the behavior of dielectric and magnetic materials in external fields.
- CO3:** formulate and use Maxwell's equations in both differential and integral forms to describe electromagnetic field dynamics and energy conservation in various media.
- CO4:** evaluate the propagation characteristics of electromagnetic waves in conducting and dielectric media.
- CO5:** interpret the relativistic formulation of electrodynamics and apply the basic principles of quantum electrodynamics (QED).

### Board of Studies (BoS):

### Academic Council:

15<sup>th</sup> BoS of Physics Department held on 18/07/2025

24<sup>th</sup> AC held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	H	L	M	H	M	L	M	M	M	H
CO2	H	L	H	M	H	M	H	H	M	H
CO3	L	L	M	H	M	M	M	H	H	M
CO4	H	L	M	H	M	M	M	H	M	H
CO5	L	L	M	H	M	M	H	M	M	M

\* Legend: L – Low (1), M – Medium (2), H – High (3).

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<b>PHF 6202</b>	<b>QUANTUM MECHANICS</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>SDG: 04</b>		<b>3</b>	<b>1</b>	<b>0</b>	<b>4</b>

**COURSE OBJECTIVES:**

- COB1: To understand the basic concepts of quantum mechanics.
- COB2: To arrive at eigenvalues and eigenfunctions of certain exactly solvable systems.
- COB3: To provide the insights on the time dependent and independent perturbation theories.
- COB4: To acquire knowledge on the scattering theory and angular momentum operators.
- COB5: To explore the concepts of relativistic quantum mechanics.

**MODULE I FOUNDATIONS OF QUANTUM MECHANICS L:9 T:3 P:0**

Postulates of quantum mechanics - Schrödinger equation: Time-dependent and Time-independent Schrödinger equation and its solution - Physical meaning and conditions on admissible wave functions - Conservation of probability- Expectation value - Ehrenfest's theorem - Basic postulates. Operator Formulation: Linear operator - Adjoint and self-adjoint operators - Commuting and non-commuting operators - Commutator - Simultaneous eigenfunctions - Heisenberg uncertainty relation.

**MODULE II EXACTLY SOLVABLE SYSTEMS L:9 T:3 P:0**

One and three dimensional Linear harmonic oscillator: Eigenvalues and eigenfunctions by solving the one dimensional Schrödinger equation- Particle in a box – Rectangular potential barrier potential – Tunnel effect – Rigid rotator – Hydrogen atom.

**MODULE III APPROXIMATION METHODS L:9 T:3 P:0**

Time independent perturbation theory: Equations in various orders of time independent perturbation theory for non- degenerate case: first and second order corrections- Stark effect – Zeeman effect- Application to ground state of Helium atom – Time dependent perturbation theory: harmonic perturbation (Fermi-Golden Rule) - Adiabatic, Sudden Approximation perturbation.

**MODULE IV SCATTERING THEORY AND ANGULAR L:9 T:3 P:0  
MOMENTUM**

Scattering theory: Scattering amplitude and cross-section – Green’s function approach -- Born approximation and its application to square-well and screened Coulomb potentials. Angular momentum: Components of orbital angular momentum – Properties of  $L$  and  $L^2$  – Eigen pairs of  $L^2$  and  $L_z$  – Eigen states and Eigen values of  $J^2$  and  $J_z$  – addition of angular momentum – Glebsch Gorden coefficients - spin angular momentum – Pauli’s spin matrices.

**MODULE V RELATIVISTIC QUANTUM MECHANICS L:9 T:3 P:0**

Klein-Gordon equation for a free particle - Probability and current densities - Plane wave solutions - Dirac relativistic equation for a free particle - Dirac matrices and their properties - Probability and current densities - Plane wave solutions – Significance of Negative eigenstates - Zitterbewegung: jittery motion of a free particle - Spin of a Dirac particle.

**L – 45; T – 15; P – 0; Total Hours: 60**

**TEXT BOOKS:**

1. A.K. Ghatak and S. Lokanathan, Quantum Mechanics: Theory & Applications, 5th edition Macmillan, Chennai, 2004.
2. P M Mathews, K.Venkatesan ,Text Book of Quantum Mechanics, 2nd Ed, Tata McGraw-Hill Education, 2017.
3. S L Gupta, V Kumar, H V Sharma, Quantum Mechanics, Jai Prakash Nath Publications, 2015.

**REFERENCES:**

1. David J. Griffiths, Introduction to Quantum Mechanics, Pearson Publication, 2020.
2. L. Schiff, Quantum Mechanics, Tata McGraw Hill, New Delhi, 4th edition, 2014.
3. Satya Prakash, Quantum Mechanics, Sultan Chand Publishers, New Delhi, 2004.
4. S. Rajasekar, R. Velusamy, Quantum Mechanics I: The Fundamentals, CRC Press, 2014.
5. R. Shankar, Principles of Quantum Mechanics (Springer, New Delhi, 2007).
6. N. Zettili, Quantum Mechanics Concepts and Applications John Wiley & Sons, 2009.

**COURSE OUTCOMES:**

**CO1:** Comprehend the basics of quantum mechanics and to apply it in

different branches of Physics.

- CO2:** Analyze certain exactly solvable systems
- CO3:** Enable the students to explore the different approximation methods used in quantum mechanics
- CO4:** Familiarize with the concepts of scattering theory and angular momentum and its importance.
- CO5:** Understand the applications of relativistic quantum mechanics.

**Board of Studies (BoS):**

15<sup>th</sup> BoS of Physics Department held on  
18/07/2025

**Academic Council:**

24<sup>th</sup> AC held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	M	L	L	H	L	L	L	H	H	M
CO2	M	M	L	L	L	H	M	M	H	H
CO3	M	L	H	L	L	L	L	M	H	M
CO4	L	M	M	H	H	L	L	M	H	H
CO5	L	L	L	L	L	L	L	H	M	H

\* Legend: L – Low (1), M – Medium (2), H – High (3).

**SDG 4:** Ensuring inclusive and equitable quality education for all persons and promote lifelong learning opportunities.

Statement:

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<b>PHF 6203</b>	<b>ADVANCED ELECTRONICS AND</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>SDG: 04</b>	<b>INSTRUMENTATION</b>	<b>4</b>	<b>0</b>	<b>0</b>	<b>4</b>

**COURSE OBJECTIVES:**

- COB1:** To understand the characteristics and performance of semiconductor devices.
- COB2:** To acquire the knowledge on circuit design using amplifiers and oscillators.
- COB3:** To explore the operations of arithmetic circuits and their implementation in digital systems.
- COB4:** To learn the digital techniques in the signal processing and data transmission.
- COB5:** To gain a comprehensive exposure in Nanoelectronics

**MODULE I      ANALOG ELECTRONICS: OPERATIONAL      L: 12    T: 0    P: 0**  
**AMPLIFIERS AND ITS MATHEMATICAL**  
**OPERATIONS**

Basic Op-Amp configuration - Design, analysis and simulation of Op-Amp - Differential input Voltage - Push - pull output stage - Real world limitations of Op-Amp - Voltage offset - input bias and input offset current - Differential input resistance - Slew rate - Fundamental Op-Amp circuits - Voltage follower - amplifying analog signal - difference amplifier - Summing amplifier - I to V Conversion.

**MODULE II      ANALOG ELECTRONICS: FEEDBACK      L: 12    T: 0    P: 0**  
**AMPLIFIERS AND OSCILLATORS**

Feedback Concepts - gain with feedback - effect of feedback on gain stability, distortion, bandwidth, input and output impedances – Negative impedance- Topologies of feedback amplifiers - Analysis of series-series, shunt-shunt and shunt-series feedback amplifiers - stability problem - Gain and Phase-margins - Frequency compensation - Oscillators - Barkhausen criterion for oscillation - phase shift, Wien bridge - Hartley & Colpitt's oscillators - Analog simulation circuits: Solving simultaneous equations, solving 2nd order linear (harmonic oscillator) - Nonlinear oscillator: chaotic circuits - characteristics.

**MODULE III      DIGITAL ELECTRONICS      L: 12    T: 0    P: 0**

Logic gates - Combinational Digital Circuits: Arithmetic Building blocks, Half & Full Adders

and Half & Full Subtractors, multiplexers, De-multiplexers, encoders, decoders - Flip-flops, RS, Clocked SR, JK, D, T, master-slave Flip flop – Conversion of Flip flop - shift registers – ripple counters – synchronous counters and asynchronous counters (4-bit counter). DAC: Accuracy-Resolution- Variable Resistor Network, R-2R ladder Network - ADC: Accuracy-Resolution-Successive Approximation-Dual Slope - Microprocessor architecture (8085,8086,8088) – microcontroller (8051).

**MODULE IV INSTRUMENTATION****L: 12 T: 0 P: 0**

Signal generators - Function generators - Wave Analysers - Harmonic distortion Analysers - spectrum analysis - Signal conditioning – Digital signal processing and DSP systems - DSP processors - digital filters - Audio and Speech Processing- Amplitude modulation - Frequency modulation - Phase modulation - Telecommunications - Bio - Medical Instrumentation - ECG - EEG - Recording Techniques - Bio sensors.

**MODULE V NANO-ELECTRONICS****L: 12 T: 0 P: 0**

Nanoscale Electronics: Background – The current state of Microelectronics and extensions to the nanoscale – Nanotechnology based strategies: Single electron tunneling and Molecular wires – Low dimensional structures: Quantum wells, Quantum wires and Quantum dots - Quantum Interference devices: Split gate transistor – Electron wave transistor – Resonant tunneling phenomena and its application in diodes and transistors - Current nano electronic devices: Quantum effects in MOSFETS – Strained silicon – Fully depleted SOI MOSFET – Double gate MOSFET – Multi gate MOSFETS.

**L – 60; Total Hours: 60****TEXT BOOKS:**

1. Albert Paul Malvino, David J. Bates, Patrick E. Hoppe, Electronic Principles (McGraw-Hill, New Delhi, 2020).
2. Thomas F.Schubert,Jr. and Ernest M. Kim, Fundamentals of Electronics: Book 1,2,3,4 (Morgan & Claypool Publishers, 2016).
3. Horowitz and Hill, The Art of Electronics, 3rd Edition, (Cambridge University Press, 2015).
4. Ram B, fundamentals of microprocessors and microcontrollers 8<sup>th</sup> Edition, Dhanpat Rai publications Ltd, New Delhi (2012)

**REFERENCES:**

1. H.S.Kalsi, Electronic Instrumentation (McGraw-Hill, New Delhi, 2010).
2. M. Lakshmanan, K. Murali, Chaos in Nonlinear Oscillators: Controlling and Synchronization, (World Scientific, 1996).
3. D.P. Leach, A.P. Malvino, and G. Saha, Digital Principles and Applications, 8<sup>th</sup> Ed. (McGraw Hill, 2014).
4. N. Balabanian and B. Carlson, Digital Logic Design Principles (John Wiley & Sons, 2000).
5. M.Morris Mano and Michael Ciletti, Digital Design (Pearson, Harlow, 2019).
6. Anil K.Maini, Digital Electronics: Principles, Devices and Applications (John Wiley & Sons Ltd., 2007).
7. P. Lapsley, J. Bier, A. Shoham and E. A. Lee, DSP Processor Fundamentals (Wiley Edition).

**COURSE OUTCOMES:**

- CO1:** construct various amplifier circuits for diverse applications.
- CO2:** develop and implement digital systems using combinational and sequential logic building blocks.
- CO3:** compare and correlate various types of digital electronic circuit design.
- CO4:** select and utilize appropriate electronic instrumentations for specific applications.
- CO5:** Enumerate the knowledge in nanoelectronics

**Board of Studies (BoS):**

15<sup>th</sup> BoS of Physics Department held  
on 18/07/2025

**Academic Council:**

24<sup>th</sup> AC held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO2
CO1	H	H	H	H	L	L	H	M	H	H
CO2	H	L	M	H	M	L	H	H	M	H
CO3	H	M	M	H	M	H	H	H	H	M
CO4	H	H	H	H	H	M	H	M	M	H
CO5	H	H	H	H	H	H	H	M	M	H

\* Legend: L – Low (1), M – Medium (2), H – High (3).

**SDG 4:** Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

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<b>PHF 6204</b>	<b>ADVANCED ELECTRONICS LABORATORY</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>SDG: 04</b>		<b>0</b>	<b>0</b>	<b>4</b>	<b>2</b>

### **COURSE OBJECTIVES:**

- COB1:** To give a practical knowledge of basic and essential electronics.
- COB2:** To study the working principles of the elementary electronic components.
- COB3:** To design analog simulation, filter circuits, optoelectronic and electronic instrumentation.
- COB4:** To introduce the applications of digital circuits, microprocessors and microcontrollers..
- COB5:** To explore the properties of nonlinear circuit and simulations.

### **Any fifteen experiments (any 15)**

1. Measurement of op-amp parameters.
2. Basic operational amplifier circuits: Comparator, inverting amplifier, non-inverting amplifier, adder, difference amplifier, integrator, differentiator, summing-integrator.
3. Construction of simultaneous equation solving circuit using op-amps.
4. Construction of op-amp active filters - LPF, HPF, BPF.
5. Design of phase shift and Wien's Bridge oscillators.
6. 555 timer based astable multi-vibrator and Schmitt trigger circuits.
7. Construction of relaxation oscillators using Op-Amp.
8. Construction of op-amp instrumentation amplifier.
9. DAC using R-2R network.
10. ADC using IC-0800 or IC-0804
11. Construction of three terminal voltage regulator based circuits (LM 7805, LM7809).
12. Verification of truth tables of OR, AND, NOR, NAND logic gates.
13. Construction of XOR logic using universal logic gates.
14. Design and implementation of half/full-adder circuits.
15. 8085/8086 microprocessor based experiments.
16. Chaotic circuit simulation and analysis.
17. Effect of nonlinearity on oscillatory circuits.
18. Plotting the V-I Characteristics of the Chua's diode.
19. Characteristics curve of FET (BFW10).

## 20. MOSFET Drain current and Transfer Characteristics (2N7000)

**L – 0; T – 0; P – 60; Total Hours: 60****COURSE OUTCOMES:**

- CO1:** Draw the characteristic curve of FET, Op-amp, negative impedance converter.
- CO2:** Design op-amp circuits to carry-out mathematical operations.
- CO3:** Understand nonlinear behaviour of devices and circuits.
- CO4:** Design complex digital electronic circuits with universal logic gates.
- CO5:** Independently operate key electronic measurement equipment.

**Board of Studies (BoS):**

15<sup>th</sup> BoS of Physics Department held on  
18/07/2025

**Academic Council:**

24<sup>th</sup> AC held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	H	L	L	L	L	L	M	H	M	H
CO2	H	L	M	M	L	L	M	M	H	H
CO3	H	M	H	M	L	M	H	H	H	M
CO4	H	M	H	M	L	M	H	M	H	M
CO5	H	M	H	H	L	M	H	H	H	H

\* Legend: L – Low (1), M – Medium (2), H – High (3).

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<b>GEF 6202</b>	<b>RESEARCH METHODOLOGY AND IPR</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>SDG: 4, 9, 11 and 15</b>		<b>3</b>	<b>1</b>	<b>0</b>	<b>4</b>

**COURSE OBJECTIVES: Students will be trained to**

- COB1:** Basic concepts of Research and formulation.
- COB2:** Safety in research laboratory and research data collection.
- COB3:** Impart knowledge for enabling students to develop data analytics skills and valid interpretation.
- COB4:** write Scientific and Technical reports and Thesis
- COB5:** Familiar the Intellectual Property Rights.

**MODULE I INTRODUCTION TO RESEARCH L: T: P: 0  
METHODOLOGY AND RESEARCH 12 0  
FORMULATION**

Research: Objectives, Motivation and types - Approaches, Significance of Research, Research process, Criteria of good research, Limitations Encountered by researchers - Defining and formulating the research problem, selecting the problem, necessity of defining the problem, importance of literature review in defining a problem, literature review - primary and secondary sources, reviews, monograph, patents, research databases, web as a source, identifying gap areas from literature and research database. Formulating working hypotheses.

**MODULE II GOOD LABORATORY PRACTICES, L: T: P: 0  
SAFETY and DATA COLLECTION 10 2**

Introduction: History, definition, Principles, Good Laboratory Practices (GLP) and its application GLP training: Stepwise implementation of GLP and compliance monitoring, Safety Symbols, Science Safety Rules - Dress Code, First Aid, Heating and Fire Safety - Observation and Collection of data, methods of data collection; Primary and secondary; data processing, analysis strategies and tools, data analysis with statistical tools (Hypothesis testing, large and small sample test). Importance of negative results.

**MODULE III DATA ANALYSIS and DRAWING****L: T: P: 0  
12 0**

Analyzing the data and drawing structures / schemes / flow charts using Chemdraw and Chems sketch - Measures of central tendency - mean median and mode - Sampling methods - Data analysis using Excel, Origin and Sigma plot - data analysis with statistical tools (Sigma STAT, SPSS student, ANOVA) - hypothesis testing - Importance and scientific methodology in recording results - Error significance - Conceptions of error of measurement - absolute and relative errors, true score theory and generalisability theory.

**MODULE IV RESEARCH ETHICS and TECHNICAL WRITING****L: T: P: 0  
08 4**

Introduction to ethics, scientific misconduct - causes and effects; fabrication; authorship issues, The investigation and punishment of scientific misconduct (Erratum and Retraction) - Different types of scientific and technical publications - Definition and importance of Journal Impact factor, COPE guidelines, Cite Scores and Citation Indexes. Technical writing skills for report, synopsis, thesis and book chapter - . Preparing manuscripts for international journals - softwares; MS Office/LATEX, Grammarly; Mendeley; detection of similarity index / plagiarism / AI support by Turnitin as per UGC Norms.

**MODULE V INTELLECTUAL PROPERTY RIGHTS****L: T: P: 0  
08 4**

Basics of Intellectual Property - Intellectual Property system in India, IP Research, and Universities - Patents Act, 1970, Patents—From ball pens to biologics - Patentable subject matter, Rights conferred Exceptions, Term of protection and Conditions on Patent applicants and patent process. Trade Mark Act, 1999, Trade secrets, The Designs Act, 2000, Copy Right, Royalty, Geographical indications, Industrial designs, Trade related aspects of Intellectual Property Rights (TRIPS); development of TRIPS complied regime in India. Enforcement of Intellectual Property Rights, Function of UNESCO in IPR maintenance.

**L - 50; T - 10; P - 0; Total Hours: 60****TEXT BOOKS:**

1. Cooper Donald R, Schindler Pamela S and Sharma JK., 2012. "Business Research Methods", Tata McGraw Hill Education, 11<sup>th</sup> Edition.

2. Kothari C.R., "Research Methodology, Methods and Techniques", Wiley Eastern Ltd., NewDelhi, 1991.

**REFERENCES:**

1. Anthony, M., Graziano, A.M. and Raulin, M.L., 2009. Research Methods: A Process of Inquiry, Allyn and Bacon.
2. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
3. Day, R.A., 1992. How to Write and Publish a Scientific Paper, Cambridge University Press.
4. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, Ess Ess Publications. 2 volumes
5. Essentials of Research Design and Methodology Geoffrey R. Marczyk, David DeMatteo, David Festinger, 2005. John Wiley and Sons Publishers, Inc
6. Biochemical Calculations: How to Solve Mathematical Problems in General Biochemistry, 2nd Edition, Irwin H. Segel, 1976. John Wiley and Sons Publishers, Inc
7. R Arora. Encyclopaedia of Research Methodology in Biological Sciences., Anmol Publishing, 2004.
8. Coghill M. and Gardson L.R., The ACS Style Guide Effective Communication of Scientific Information, 3rd Edn., Oxford University Press, 2006.

**COURSE OUTCOMES: The students will be able to**

- CO1:** recognize the basic concepts of research and its methodologies
- CO2:** select appropriate safety measurements and data collection methods
- CO3:** Apply various statistical hypothesis testing and interpret the results.
- CO4:** write scientific report as journal article, thesis and technical proposal for funding.
- CO5:** propose research findings as patents, copyrights, trademarks and other IPR.

**Board of Studies (BoS):** 14<sup>th</sup> BoS **Academic Council:**  
of Department of Chemistry held 24<sup>th</sup> ACM held on  
on 17.07.2025 26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	H	H				M		H		
CO2		H		M	M	H	H		H	H
CO3		H			M			M	M	
CO4			H				M			
CO5	H					H	M			H

\* Legend: L – Low (1), M – Medium (2), H – High (3).

SDG 4: Quality Education

SDG 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

SDG 11: Sustainable Cities and Communities

SDG 15: Life on Land

Statement:

The understanding of concepts of high quality research, innovative thinking, knowledge on sustainable development and service to the society and mankind through quality research.

<b>ENF 6281</b>	<b>PROFESSIONAL COMMUNICATION</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>SDG: 4 &amp; 8</b>		<b>0</b>	<b>0</b>	<b>2</b>	<b>1</b>

**COURSE OBJECTIVES:**

- COB1:** To introduce the fundamentals of professional communication in workplace contexts.
- COB2:** To develop structured presentation and public speaking skills.
- COB3:** To develop students' proficiency in written correspondence, including emails, and reports.
- COB4:** To enhance awareness and use of body language in professional settings
- COB5:** To instil appropriate workplace etiquette and digital professionalism.

**MODULE I COMMUNICATION AT THE WORKPLACE P: 6**

Language and communication fundamentals, Types of workplace communication, Formal and informal Communication, Direction and flow of Communication- Organizational communication and interpersonal dynamics, 7 Cs of Communication - Ethical use of AI assisted communication tools

**MODULE II PRESENTATION & PUBLIC SPEAKING SKILLS P: 6**

Importance of presentation skills, Managing public speaking anxiety, Structured planning and delivery of presentations, Use of visual aids and technology - Interactive tools

**MODULE III CORRESPONDENCE AT WORK P: 9**

Digital correspondence - Email Writing and Etiquette, Report Writing: Incident Reports, Feasibility Reports, and Executive Summaries

**MODULE IV BODY LANGUAGE P: 5**

Fundamentals of body language in professional communication, Types of non-verbal cues, posture -Interpreting and responding to non-verbal signals in interpersonal and group contexts, Cultural variations in body language and their implications in global communication

**MODULE V WORKPLACE ETIQUETTE P: 4**

Workplace etiquette, Cultural sensitivity in globalized work environments, Gender sensitivity and inclusivity, DEI, Netiquette and digital professionalism - video conferencing, Professional networking (Social media, LinkedIn, etc.), Virtual team dynamics

**P – 30; Total Hours:30**

**TEXT BOOKS:**

1. Course material by the Department of English

**REFERENCES:**

1. Bovee, C. L., & Thill, J. V. *Business Communication Today* (14<sup>th</sup> ed.). Pearson, 2021.
2. Cardon, P. W., & Marshall, B. The hype and reality of social media use for work collaboration and team communication. *International Journal of Business Communication*, 52(3), 2015, 273–293.
3. Guffey, M. E., & Loewy, D. *Essentials of Business Communication* (11<sup>th</sup> ed.). Cengage Learning, 2020.
4. Jones, D. A., & Pittman, M. The digital professionalism paradox: Workplace norms and expectations in the era of online communication. *Journal of Applied Communication Research*, 49(3), 2021, 283–301.
5. Keyton, J., & Smith, F. L. M. Communication practices of work teams: Task, social, and identity functions. *Journal of Business Communication*, 46(4), 2009, 402–426.
6. Krizan, A. C., Merrier, P., Logan, J., & Williams, K. *Business Communication* (9<sup>th</sup> ed.). Cengage Learning, 2016.
7. Lesikar, R. V., Flatley, M. E., Rentz, K., & Lentz, P. *Lesikar's Business Communication: Connecting in a Digital World* (13<sup>th</sup> ed.). McGraw-Hill Education, 2019.
8. Madlock, P. E. The link between leadership style, communicator competence, and employee satisfaction. *Journal of Business Communication*, 45(1), 2008, 61–78.
9. Raman, M., & Sharma, S. *Technical communication: Principles and practice* (3<sup>rd</sup> ed.). Oxford University Press, 2015.
10. Robles, M. M. Executive perceptions of the top 10 soft skills needed in today's workplace. *Business Communication Quarterly*, 75(4), 2012, 453–465. <https://doi.org/10.1177/1080569912460400>

**COURSE OUTCOMES:**

On completion of the course, students will be able to

- CO1:** Demonstrate clarity in professional communication by selecting appropriate modes and formats for workplace interactions.
- CO2:** Deliver structured presentations with confidence, using relevant verbal and visual communication techniques.
- CO3:** Produce clear and effective written correspondence, including emails, and formal reports.
- CO4:** Interpret and apply non-verbal communication cues appropriately in professional contexts.
- CO5:** Exhibit workplace etiquette, digital conduct, and cultural sensitivity in professional environments.

**Board of Studies (BoS):**

18<sup>th</sup> BoS of the Department of English held  
on 04.06.2025

**Academic Council:**

24<sup>th</sup> AC held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5
CO1					
CO2					
CO3					
CO4					
CO5					

Legend: L – Low (1), M – Medium (2), H – High (3).

**SDG 4:** Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

**Statement:** This course ensures that the students acquire quality education and are also made eligible to obtain productive and decent employment.

**SDG 8:** Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

**Statement:** This course equips students with the competencies required for employment in a dynamic global workforce.

<b>PHF 6205</b>	<b>MINI PROJECT</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>SDG: 4</b>		<b>0</b>	<b>0</b>	<b>6</b>	<b>2</b>

### COURSE OBJECTIVES:

**COB1:** To develop a foundational understanding and practical exposure in emerging research areas through hands-on training.

**COB2:** To enhance professional skills, analytical thinking, problem-solving abilities, and research aptitude through project-based learning.

### General Instructions

- ❖ The mini project will serve as a foundation for students to acquire hands-on training and practical knowledge in emerging research areas.
- ❖ During the second semester of the programme, students will be allotted a research supervisor based on their field of interest.
- ❖ All students must submit a project report upon successful completion of the mini project. The report should include an introduction, a literature survey, a brief experimental work or methodology, results, and a discussion.
- ❖ A Viva Voce examination will be conducted at the end of the semester.
- ❖ An external faculty member will be invited to participate in the evaluation of the Viva Voce examination.
- ❖ The mini project will serve as preparatory training for students in executing the major project during the second year of the programme.

### Course Outcomes (COs)

**CO1:** Demonstrate practical competency gained through hands-on training with a deeper understanding of Physics concepts.

**CO2:** Apply analytical thinking and problem-solving skills to support research-oriented career development.

#### Board of Studies (BoS):

15<sup>th</sup> BoS of Physics Department held  
on 18/07/2025

#### Academic Council:

24<sup>th</sup> AC held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	H	M	H	M	M	H	M	H	M	H
CO2	M	M	M	H	H	H	H	H	M	H

**Note:** L - Low Correlation      M - Medium Correlation      H - High Correlation

**SDG 4:** Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

**Statement:**

The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and promote learning opportunities at all times.

**PROFESSIONAL ELECTIVES**

<b>PHFY 101</b>	<b>CRYSTAL GROWTH AND</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>SDG: 4</b>	<b>CHARACTERIZATION</b>	<b>2</b>	<b>0</b>	<b>1</b>	<b>3</b>

**COURSE OBJECTIVES:**

- COB1:** To infer the basic understanding of Crystal-Symmetry operations and various defects in crystals
- COB2:** To understand and compare the various solution-based Crystal Growth techniques
- COB3:** To understand the principle in the methods involved in the growth of crystal using the melt growth process
- COB4:** To gain knowledge on the vapour growth and epitaxial process
- COB5** To evaluate the structural, spectral and optical properties of single crystal and to analyze their properties

**MODULE I CRYSTAL GROWTH THEORY – AN L:6 T: P: 3**  
**INTRODUCTION**

Symmetry elements, operations - translational symmetries - point groups - space groups – Surface energy theories – Gibbs theory, Adsorption layer theories – Gibbs - Volmer theory, Kossel' 's model, BCF theory, Nucleation, types of nucleation, thermodynamical parameters involved in nucleation.

**MODULE II SOLUTION GROWTH TECHNIQUES L:6 T: P: 3**

Introduction to crystal growth – nucleation – Solubility curve- Measurement of supersaturation - solution growth methods – low and high-temperature solution growth methods – recrystallization process – vapour growth – Crystal growth in gel – Growth of biological crystals – Hydrothermal technique – Sol-gel growth – unidirectional growth of crystals from solution, Accelerated crucible rotation technique (ACRT).

**MODULE III MELT GROWTH L:6 T: P: 3**

Temperature measurement and control – Starting materials and purification - conservative and non-conservative process – Bridgman method – Czochralski method – Verneuil method – Zone melting – Zone refining- Skull melting- Flux growth method.

**MODULE IV VAPOUR GROWTH AND EPITAXY****L:6 T: P: 3**

Growth of crystals from vapour phase - Physical vapour deposition - Chemical vapour transport - Open and closed system - Thermodynamics of chemical vapour deposition process - Physical, thermo-chemical factors affecting growth process. Epitaxy: Liquid Phase Epitaxy (LPE) - Vapour Phase Epitaxy (VPE)- Metalorganic Vapour Phase Epitaxy - (MOVPE)-Molecular Beam Epitaxy (MBE) - Atomic Layer Epitaxy (ALE)

**MODULE V CHARACTERIZATION TECHNIQUES AND L:6 T: P: 3  
INTRODUCTION TO NONLINEAR OPTICS**

Principles, instrumentation and applications for single crystal XRD, powder XRD, Fourier Transform Infrared Spectroscopy (FT-IR), UV-Vis-NIR spectroscopy, Dielectric analysis, Thermogravimetric analysis – TGA/DTA/DSC; Introduction to Nonlinear Optics, phase matching, various NLO process – Second Harmonic Generation (SHG), Kurtz Perry technique, Third Harmonic Generation (THG), Z-scan analysis, sum frequency and difference frequency generation and self-focussing, optical phase conjugation, laser damage threshold analysis .

**L – 30; T – 0; P – 15; Total Hours: 45****LIST OF EXPERIMENTS:**

1. Growth of crystal by slow evaporation technique using the universal solvent.
2. Growth of crystal by slow evaporation technique using the organic solvent.
3. Determine of melting point of the given material.
4. Determine of solubility of a material gravimetrically for different solvents.
5. Demonstrate of second order nonlinear optics and calculate the laser damage threshold.
6. Demonstrate of third order nonlinear harmonic generation using Z-Scan setup.
7. Calculate the hardness number, material constant, elastic stiffness constant for the given NLO
8. Analyze the surface etching of the given crystal for different solvents.

**TEXT BOOKS:**

1. Ivan V. Markov, Crystal Growth for Beginners: Fundamentals of Nucleation, Crystal Growth and Epitaxy, World Scientific, (2004).
2. Donald E. Sands, Introduction to Crystallography, Dover Publications (1994).

**REFERENCES:**

1. Brice J.C., Crystal Growth Processes, John Wiley and Sons, New York, (1987).
2. J. W. Mullin, Crystallisation, Butterworth Heinemann: Oxford, UK, (2001).
3. Santhana Ragavan P. and Ramasamy P., Crystal Growth Processes and Methods, KRU Publications, Kumbakonam, (2001).
4. Muthu Senthil Pandian and P. Ramasamy, Characterization of Single Crystals, Royal Book Publications (2025)
5. Chunfei Li, Nonlinear Optics - Principles and Applications, Springer, (2017).

### COURSE OUTCOMES:

- CO1:** Identify and describe symmetry elements, point groups, space groups, and crystal structures.
- CO2:** Explain and interpret theories of surface energy and nucleation processes.
- CO3:** Apply the principles of crystal growth techniques in laboratory practices.
- CO4:** Understand the concept related to epitaxial and vapour growth process.
- CO5** Evaluate crystal properties techniques holistically and extend it to study of non-linear optical properties

### Board of Studies (BoS):

15<sup>th</sup> BoS of Physics Department held  
on 18/07/2025

### Academic Council:

24<sup>th</sup> AC held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	H	L	H	L	L	L	H	H	M	H
CO2	H	L	H	L	L	M	H	H	M	M
CO3	M	L	L	L	L	L	H	M	H	H
CO4	L	L	H	M	M	M	H	H	H	M
CO5	H	M	H	L	H	M	H	M	M	H

\* Legend: L – Low (1), M – Medium (2), H – High (3).

SDG 4: Ensuring inclusive and equitable quality education for all persons and promote lifelong learning opportunities.

Statement : The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and promote learning opportunities at all times.

M.Sc	Physics	Regulations 2025			
<b>PHFY 102</b>	<b>FUNCTIONAL MATERIALS AND ITS</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>SDG: 4</b>	<b>APPLICATIONS</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

### **COURSE OBJECTIVES:**

- COB1:** To introduce the fundamental properties, structure of smart materials.
- COB2:** To gain knowledge on application of function materials for sensor applications
- COB3:** To explore the electro rheological functional materials and their properties
- COB4:** To understand the theory behind piezoelectric materials
- COB5:** To make the students understand the applications of smart materials towards shape memory alloys

### **MODULE I INTRODUCTION TO FUNCTIONAL MATERIALS L:9 T:0 P: 0**

Brief introduction – Intelligent /Smart materials - Structural aspects, Symmetry requirements – Generation of smart materials – Diverse areas of intelligent materials – Primitive functions of intelligent materials – Structure - Property Relationships – Examples of intelligent materials, structural materials, Electrical materials, bio-compatible materials – Intelligent biological materials - Biomimetics – self-healing – superhydrophobic materials - self-assembled structures - Wolff's law – Technological applications of Intelligent materials.

### **MODULE II STRUCTURAL PROPERTIES OF FUNCTIONAL MATERIALS L: 9 T:0 P:0**

Principal ingredients of smart materials – Thermal materials – Microscopic origins of Multifunctionality - Heckmann diagram - Sensing technologies – Micro sensors – Intelligent systems – Hybrid smart materials – Passive sensory smart structures– Reactive actuator based smart structures – Active sensing and reactive smart structures – 2D functional quantum materials - Fundamental and properties of two-dimensional materials in sensing - Smart skins – Aero elastic tailoring of airfoils – Synthesis of future smart systems.

### **MODULE III ELECTRO-RHEOLOGICAL (FLUIDS) L: 9 T:0 P:0 FUNCTIONAL MATERIALS**

Suspensions and electro-rheological fluids – Bingham-body model – Newtonian viscosity and non-Newtonian viscosity – Principal characteristics of electro rheological

fluids – The electro-rheological phenomenon – Charge migration mechanism for the dispersed phase – Electro-rheological fluid domain – Electrorheological fluid actuators – Electro-rheological fluid design parameter – Applications of Electrorheological fluids.

#### **MODULE IV PIEZOELECTRIC FUNCTIONAL MATERIALS L: 9 T:0 P:0**

Background – Electrostriction – Classification of ferroic materials and Venn diagram; Piezoelectrics, Pyroelectrics and Ferroelectrics: Phenomena, Properties – Industrial piezoelectric materials – PZT – PVDF – film – Properties of commercial Piezoelectric materials – Properties of piezoelectric film (explanation) – Smart materials featuring piezoelectric elements – Smart composite laminate with embedded piezoelectric actuators – SAW filters.

#### **MODULE V SHAPE – MEMORY (ALLOYS) FUNCTIONAL MATERIALS L: 9 T:0 P:0**

Background on shape – Memory alloys (SMA) - one-way SMA - pseudo elasticity-two-way SMA- Nickel – Titanium alloy (Nitinol) – Materials characteristics of Nitinol – Martensitic transformations – Austenitic transformations – Thermoelastic martensitic transformations – Cu based SMA, chiral materials – Applications of SMA – Continuum applications of SMA fasteners – SMA fibers – reaction vessels, nuclear reactors, chemical plants, etc. – Micro robot actuated by SMA – SMA memorization process (Satellite antenna applications) SMA blood clot filter – Impediments to applications of SMA – SMA plastics – Primary molding – secondary molding – Potential applications of SMA plastics

**L – 45; Total Hours: 45**

#### **TEXT BOOKS:**

1. Newnham, R.E., Properties of Materials: Anisotropy, Symmetry, Structure, Oxford University Press Inc., 2005
2. M.V.Gandhi and B.S. Thompson, Smart Materials and Structures Chapman and Hall, London, First Edition, 1992
3. T.W. Deurig, K.N.Melton, D.Stockel and C.M.Wayman, Engineering aspects of Shape Memory alloys, Butterworth –Heinemann, 1990
4. C.A.Rogers, Smart Materials, Structures and Mathematical issues, TechnomicPublishing Co., USA, 1989.
5. Newnham, R.E., Structure-property relations, Vol. 2, Springer Science & Business Media, 2012.

**REFERENCES:**

1. Banks, C., E., Browson, D.A.C., 2D Materials, Characterization, Production and Applications, CRC Press, 2017
2. Hywel, M., Rout, C.S., Late, D.J., Late Fundamentals and Sensing Applications of 2D Materials, Elsevier, 2021
3. Meyers, M.A., Chen P.Y., Biological Materials Science - Biological Materials, Bioinspired Materials and Biomaterials, Cambridge University Press, 2014
4. Silva, D., Clarence W., Sensors and actuators: Engineering system instrumentation. CRC Press, 2015
5. Rupitsch, Johann, S., Piezoelectric Sensors and Actuators. Springer-Verlag Berlin Heidelberg, Heidelberg, 2018.

**COURSE OUTCOMES:**

- CO1:** illustrate structure and properties of smart materials and their applications in Science & Technology
- CO2:** explore the various application of functional materials towards sensors technology
- CO3:** comprehend the concept behind electro rheological functional materials
- CO4:** get necessary exposure to theory and principles of piezoelectric materials
- CO5:** study the applications of smart materials towards shape memory alloys

**Board of Studies (BoS):**

15<sup>th</sup> BoS of Physics Department held  
on 18/07/2025

**Academic Council:**

24<sup>th</sup> AC held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	H	M	L	L	M	M	M	H	M	H
CO2	H	M	M	L	L	M	L	H	M	H
CO3	H	M	M	L	L	L	L	H	H	H
CO4	H	M	M	L	M	M	M	H	M	M
CO5	H	M	M	L	M	M	M	H	H	M

\* Legend: L – Low (1), M – Medium (2), H – High (3).

SDG 4 : Ensuring inclusive and equitable quality education for all persons  
and promote lifelong learning opportunities

Statement: The modules and topics mentioned in this course are designed to ensure all inclusive and thorough education with equity to all persons and promote learning opportunities at all times.

<b>PHFY 103</b>	<b>LASER AND NONLINEAR OPTICS</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>SDG:4</b>		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**COURSE OBJECTIVES:**

- COB1:** To understand the fundamental principles of laser operation.
- COB2:** To analyze the working principles of different types of laser.
- COB3:** To identify the diverse applications of laser.
- COB4:** To understand the theoretical principles of nonlinear optics.
- COB5:** To explore the advanced applications of non-linear optics.

**MODULE I PRINCIPLES OF THE LASER L: 9 T: P:**

Interaction of light and matter - absorption - spontaneous emission, and stimulated emission – Einstein coefficients and light amplification- condition for laser population inversion – laser action – pump mechanism – pulsed and continuous wave lasers – laser rate equations- two, three and four level systems – Optical resonators and Modes - Modes of a rectangular cavity and open planar resonator, spherical mirror resonators, the quality factor, line-width of laser, mode selection - Pulsed and continuous wave lasers, Q-switching, mode locking, modes of general spherical resonator.

**MODULE II PROPERTIES OF LASER BEAMS AND TYPES OF LASER L: 9 T: P:**

Coherence properties of laser, spatial and temporal coherence and directionality- Laser systems: Ruby laser – Nd:YAG laser, He-Ne laser, CO<sub>2</sub> laser, dye laser. Fiber laser: basic equations of Erbium-doped fiber, fiber amplifier, mode locking. Semiconductor laser: Basics, optical gain in semiconductors, gain coefficient, quantum well laser, semiconductor laser materials, laser diode characteristics, VCSELs, optical parametric oscillators, free electron lasers – X-ray laser – Excimer laser.

**MODULE III APPLICATIONS OF LASER L: 9 T: P:**

Defence application: Laser range finder, Laser guided Antitank Missile (Indian ATM Nag and Amogh)- High energy directed energy weapons – laser dazzlers. Industrial application: laser welding, hole drilling, laser cutting, LIDAR, data storage, laser printing. Holography; Shearography; Research and Development application: Lithography- Laser cooling – Laser Fusion and Isotope separation. Biomedical application: Eye surgery (LASIK) – Endoscopy – Dentistry;

**MODULE IV NONLINEAR OPTICS****L: 9 T: P:**

Polarization response of materials to light – linear and nonlinear polarization – origin of Nonlinearity – wave propagation in anisotropic medium, nonlinear susceptibilities and refractive index – nonlinear absorption - two photon absorption – four wave mixing – nonlinear Maxwell equation – concept of phase matching – types of phase matching – quasi phase matching - optical phase conjugation - Multiphoton Processes, Self-focusing, Self-phase-modulation, Photon Echo, Optical Switching-Stimulated Scattering: Rayleigh, Brillouin, and Raman Processes. Second harmonic generation (SHG) - sum and difference frequency generation – third harmonic generation – optical limiting - laser damage threshold.

**MODULE V ADVANCEMENT IN NONLINEAR OPTICS****L: 9 T: P:**

Nonlinear optical effects in optical waveguides and optical fibers, applications of nonlinear optics in quantum optics experiments, nonlinear effects in Bose-Einstein condensation, higher order nonlinear effects- Ultrahigh resolution laser spectroscopy – saturation spectroscopy – two-photon absorption spectroscopy – coherent Raman spectroscopy – laser polarization spectroscopy – laser cooling and trapping spectroscopy.

**L – 45; Total Hours: 45****TEXT BOOKS:**

1. B.B. Laud, Lasers and Nonlinear Optics, New Age International Publisher, (2011)
2. Robert W. Boyd, Nonlinear Optics, New Age International Publisher, (2020)
3. William T.Silfvast, Laser Fundamentals, Cambridge University Press, Cambridge, (2004).

**REFERENCES:**

1. K.Thyagarajan and A.Ghatak, Lasers: Fundamentals and Applications, Springer, New York, (2010)
2. K.R. Nambiar, Lasers: Principles, Types and Applications, New Age International Publishers Ltd, New Delhi, (2014).
3. Guang S.He, Nonlinear Optics and Photonics, Oxford University Press, Oxford, (2015)
4. Peter E.Powers and Joseph W.Haus, Fundamentals of Nonlinear Optics, CRC Press, Boca Raton, (2017).

**COURSE OUTCOMES:**

- CO1:** Explain the fundamental principles of laser.
- CO2:** Compare the working principle of lasers and to identify their application domain.

- CO3:** Apply knowledge of laser properties to identify suitable lasers for various industrial, defense, biomedical, and research applications.
- CO4:** Demonstrate the understanding of nonlinear optical phenomena.
- CO5:** Interpret advanced concepts in nonlinear optics.

**Board of Studies (BoS):**

15<sup>th</sup> BoS of Physics Department  
held on 18/07/2025

**Academic Council:**

24<sup>th</sup> AC held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	L	L	L	L	L	M	L	H	M	H
CO2	M	L	H	L	L	M	M	H	M	H
CO3	H	H	H	H	L	L	M	H	H	H
CO4	L	L	L	L	L	L	L	H	M	M
CO5	M	L	H	H	M	L	L	H	H	M

\* Legend: L – Low (1), M – Medium (2), H – High (3).

SDG 4: Ensuring inclusive and equitable quality education for all persons and promote lifelong learning opportunities.

Statement: The modules and topics mentioned in this course are designed to ensure all inclusive and thorough education with equity to all persons and promote learning opportunities at all .

<b>PHFY 104</b>	<b>MATERIALS CHARACTERIZATION</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>SDG: 4</b>		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**COURSE OBJECTIVES:**

- COB1:** To help students understand how X-ray techniques are used to study the structure and surface of materials.
- COB2:** To get knowledge on thermal analysis and magnetic properties of materials.
- COB3:** To understand the working principles of different optical and electronic microscopic techniques.
- COB4:** To study on electrical and dielectric properties of various materials
- COB5:** To compare different spectroscopic techniques towards materials perspective.

**MODULE I X-RAY TECHNIQUES****L: 9 T:0 P:0**

Introduction, Interaction of X-rays with matter (photoelectric effect, scattering, absorption) Attenuation of X-rays and Beer-Lambert Law, X-Ray Powder Diffraction - Particle size - strain determination, Single Crystal X- Ray Structure Determination, GIXRD and its applications, X-Ray Photoelectron Spectroscopy (XPS), Surface X-Ray Diffraction.

**MODULE II THERMAL AND MAGNETIC ANALYSIS****L: 9 T: 0 P:0**

Introduction – thermogravimetric 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. Magnetic Characterizations- VSM (Vibrating Sample Magnetometry), SQUID magnetometry, Mössbauer spectroscopy.

**MODULE III OPTICAL AND ELECTRON MICROSCOPIC METHODS****L: 9 T: 0 P: 0**

Optical Microscopy: optical microscopy techniques – Bright field optical microscopy – Dark field optical microscopy – phase contrast microscopy - fluorescence microscopy – Dynamic light scattering - scanning probe microscopy : Scanning Tunneling Microscopy (STM), Atomic Force Microscopy (AFM) - Scanning electron microscopy (SEM) - FESEM - EDAX - TEM - HRTEM: working principle and Instrumentation - sample preparation - Advantages/disadvantages.

**MODULE IV ELECTRICAL AND DIELECTRIC ANALYSIS L: 9 T: 0 P: 0**

Two probe and four probe methods- van der Pauw method – Hall probe and measurement – scattering mechanism – IV / CV characteristics – Dielectric analysis - Impedance analysis– thermoelectric analysis, BET analysis, Schottky barrier capacitance – impurity concentration – electrochemical C-V profiling - GCD testing – limitations, P-E loop analysis.

**MODULE V SPECTROSCOPIC TECHNIQUES L: 9 T: 0 P: 0**

Principles and instrumentation for UV-Vis-IR, FTIR spectroscopy, Photoluminescence spectroscopy, NMR spectroscopy, ESR spectroscopy, Raman spectroscopy, SIMS-proton induced X-ray Emission spectroscopy (PIXE), Mass Spectroscopy (MS, GC/MS), Atomic Absorption Spectroscopy (AAS), Inductively coupled plasma atomic emission spectroscopy (ICP-AES)

**L – 45; Total Hours: 45****TEXT BOOKS:**

1. P. Ramasamy and P. Santhana Raghavan, "Crystal Growth Processes and Methods," KRU Publications, Kumbakonam, 1999
2. Yang Leng, "Materials Characterization: Introduction to Microscopic and Spectroscopic Methods" 2nd Edition, Wiley-VCH, 2013.
3. William D. Callister Jr., David G. Rethwisch, "Materials Science and Engineering: An Introduction", 10th Edition, Wiley publications, 2018
4. Ch Sateesh Kumar, M. Muralidhar Singh, Ram Krishna, "Advanced Materials Characterization", 1<sup>st</sup> Edition, CRC Press, 2023

**REFERENCES:**

1. Stradling, R. A; Klipstain, P.C; Growth and Characterization of semiconductors, Adam Hilger, Bristol,1990.
2. Belk, J.A; Electron microscopy and microanalysis of crystalline materials, Applied Science Publishers, London, 1979.
3. Lawrence E. Murr, Electron and Ion microscopy and Microanalysis principles and Applications, Marcel Dekker Inc., New York, 1991
4. D. Kealey & P.J. Haines, Analytical Chemistry, Viva Books Private Limited, New Delhi 2002.
5. Hobart Hurd Willard, Lynne Lionel Merritt, Instrumental Methods of Analysis, 6th ed, CBS Publishers & Distributors, 1986.
6. Cullity B D., Stock S R "Elements of X-ray Diffraction", Prentice Hall, Inc 2001

7. Elton N. Kaufmann, Characterization of Materials volumes 1 and 2, John Wiley & Sons, Inc., Hoboken, New Jersey, 2003.
8. Ortiz Ortega, E., Hosseinian, H., Aguilar Meza, I. B., Rosales Lopez, M. J., Rodriguez Vera, A & Hosseini, S. "Material Characterization Techniques and Applications", Springer, 2022.

### COURSE OUTCOMES:

- CO1:** Apply X-ray techniques to analyze the structure and surface of materials.
- CO2:** Understand and interpret thermal analysis data using TGA, DTA, and DSC.
- CO3:** Use optical and electron microscopy methods to examine material details.
- CO4:** Perform electrical measurements to evaluate material properties.
- CO5:** Utilize various spectroscopic techniques for material composition analysis.

### Board of Studies (BoS):

15<sup>th</sup> BoS of Physics Department held  
on 18/07/2025

### Academic Council:

24<sup>th</sup> AC held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	H	M	L	M	L	H	H	H	M	H
CO2	M	H	M	L	M	H	H	H	M	H
CO3	H	M	M	M	L	H	H	H	H	H
CO4	H	H	M	M	L	M	H	H	M	M
CO5	H	M	M	L	L	L	H	H	H	M

\* Legend: L – Low (1), M – Medium (2), H – High (3).

**SDG 4 :** Ensuring inclusive and equitable quality education for all persons and promote lifelong learning opportunities.

**Statement :** The modules and topics mentioned in this course are designed to ensure all inclusive and thorough education with equity to all persons and promote learning opportunities at all times.

<b>PHFY 105</b>	<b>NANOSCIENCE AND TECHNOLOGY</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>SDG:</b>		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>04, 07</b>					

**COURSE OBJECTIVES:**

- COB1: To understand the principles, properties and synthesis of nanomaterials.
- COB2: To analyze advanced characterization tools and spectroscopy methods.
- COB3: To gain knowledge on the magnetic behavior at the nanoscale and their role in emerging technologies.
- COB4: To compare different nanofabrication methods and evaluate the design and working of MEMS devices.
- COB5: To identify and assess real-world applications of nanotechnology and evaluate their societal and technological impact.

**MODULE I NANOMATERIALS : FUNDAMENTALS AND SYNTHESIS PROCEDURES L: 9 T: 0 P: 0**

Evolution and scope of nanoscience and nanotechnology, Nanoscale concepts: Length scales, confinement, quantum effects, Classification of nanostructures: 0D, 1D, 2D, and 3D, Size-dependent properties of nanomaterials, clusters, quantum dots, nanowires, rods and tubes, nanoclusters, core shell nanostructure, buckyballs, carbon nanotubes, Synthesis: Bottom up and top down approach, Physical methods: molecular beam epitaxy, laser ablation, sputtering, thermal evaporation, ball milling; Chemical methods: chemical vapor deposition (CVD), sol-gel, atomic layer deposition (ALD).

**MODULE II CHARACTERIZATION TECHNIQUES L: 9 T: 0 P: 0**

X-ray-based methods: X-ray diffraction (XRD), Small-angle X-ray scattering (SAXS); Microscopy: scanning electron microscope (SEM), transmission electron microscope (TEM), scanning electron microscope (STM), atomic force microscopy (AFM); Spectroscopy: UV-Vis, FTIR, Raman; Thermal analysis: TGA, DSC, Particle size and surface area analysis (BET).

**MODULE III NANOMAGNETISM AND MAGNETIC NANOMATERIALS L: 9 T: 0 P: 0**

Magnetic moments, domains, and exchange interactions Classification: Diamagnetism, paramagnetism, ferromagnetism, antiferromagnetism, ferrimagnetism, Magnetic anisotropy in nanostructures Size-dependent magnetic behavior, VSM (Vibrating Sample

Magnetometry), SQUID magnetometry, Mössbauer spectroscopy, Applications: Data storage, spintronics, giant magnetoresistance (GMR), tunnel magnetoresistance (TMR).

**MODULE IV NANOFABRICATION AND MICRO-ELECTRO-MECHANICAL SYSTEMS DEVICES L: 9 T: 0 P: 0**

Definition and role in nanofabrication, Classification: Photolithography, Electron Beam Lithography (EBL), Nanoimprint Lithography (NIL), Etching techniques: Wet and dry etching, Definition and overview of micro-electro-mechanical systems (MEMS), Materials for MEMS: Silicon, SU-8, polymers, piezoelectrics, MEMS design and fabrication process: Bulk micromachining, Surface micromachining LIGA process.

**MODULE V APPLICATIONS OF NANOTECHNOLOGY IN VARIOUS FIELDS L: 9 T: 0 P: 0**

Drug delivery systems, Cancer therapy using hyperthermia and nano-drugs, Biosensors, Nano-enabled electrodes for energy storage (Li-ion batteries and supercapacitors), photocatalysis for water treatment, Optoelectronic devices (Solar cells, LEDs), flexible electronic devices.

**L – 45; Total Hours: 45**

**TEXT BOOKS:**

1. T. Pradeep, Textbook of nanoscience and nanotechnology, 1<sup>st</sup> Edition, McGraw Hill Education (2017).
2. Charles P. Poole Jr., Introduction to Nanotechnology, Wiley-Interscience; 1<sup>st</sup> edition (2003)
3. B. S. Murty, P. Shankar, Baldev Raj, Textbook of Nanoscience and Nanotechnology: A Pathway to Personalized Diagnosis and Treatment, Springer Nature; (2012).

**REFERENCES:**

1. C.N.R. Rao, A. Müller, and A.K. Cheetham, The Chemistry of Nanomaterials: Synthesis, Properties and Applications, Wiley-VCH; 1<sup>st</sup> edition (2004)
2. Hari Singh Nalwa, Encyclopedia of Nanoscience and Nanotechnology, American Scientific Publishers; 1<sup>st</sup> edition (2004)
3. Klaus D. Sattler, Handbook of Nanophysics: Nanoparticles and Quantum Dots, CRC Press; 1<sup>st</sup> edition (2020);
4. Sabu Thomas et al., Nanotechnology for Biomedical Applications, 1<sup>st</sup> Edition, Elsevier (2024).

5. Mansoor M. Amiji, Nanotechnology for Cancer Therapy, CRC Press; 1<sup>st</sup> edition (2006)

### COURSE OUTCOMES:

**At the end of the course, the students will be able to**

- CO1:** Understand the principles, properties and various synthesis techniques of nanomaterials.
- CO2:** Analyze the principles of modern analytical techniques such as XRD, SEM, TEM, and spectroscopy for the characterization of nanomaterials.
- CO3:** Understand the magnetic behaviour of nanomaterials for spintronic and data storage applications.
- CO4:** Explain and compare nanofabrication techniques and outline the MEMS device fabrication processes.
- CO5:** Evaluate the effectiveness of nanotechnology in practical applications such as drug delivery, water purification, optoelectronics, and energy storage.

### Board of Studies (BoS):

15<sup>th</sup> BoS of Physics Department  
held on 18/07/2025

### Academic Council:

24<sup>th</sup> AC held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	L	L	H	H	L	M	M	H	M	H
CO2	H	M	M	M	H	H	M	H	M	H
CO3	H	H	H	M	M	M	H	H	H	H
CO4	H	H	M	M	M	M	M	H	M	M
CO5	H	M	M	M	M	M	M	H	H	M

\* Legend: L – Low (1), M – Medium (2), H – High (3).

**SDG 4 :** Ensuring inclusive and equitable quality education for all persons and promote lifelong learning opportunities.

**Statement :** The modules and topics mentioned in this course are designed to ensure all inclusive and thorough education with equity to all persons and promote learning opportunities at all times.

**SDG 7:** Ensure access to affordable, reliable, sustainable and modern energy for all

<b>PHFY 106</b>	<b>OPTICAL FIBER COMMUNICATION</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>SDG: 4</b>		<b>2</b>	<b>0</b>	<b>1</b>	<b>3</b>

**COURSE OBJECTIVES:**

- COB1:** To understand the principles and classifications of fiber optic communication.
- COB2:** To introduce the various optical fiber modes, configurations, and signal degradation factors.
- COB3:** To gain knowledge on fabrication techniques and the different types of optical fiber connectors.
- COB4:** To study various optical sources and detectors in the optical communication system.
- COB5:** To explore the applications of amplifiers and networks in optical communication systems.

**MODULE I OPTICAL FIBER AND ITS PROPERTIES L: 6 T: 0 P: 3**

Introduction to optical fiber - structure of an optical fiber - Basic principle involved in optical fiber technology - Acceptance angle - Acceptance cone - Numerical aperture of a fiber - Optical fiber bundles and cables - meridional rays & skew rays - Classification of Optical Fibers: Fiber materials, single and multimode, step index and graded index fiber - Elements of an optical fiber transmission link.

**MODULE II SIGNAL DISTORTION IN OPTICAL FIBERS & MEASUREMENTS L: 6 T: 0 P: 3**

Introduction - Attenuation, absorption, scattering losses, bending loss, Core and Cladding losses -Types of Dispersion - Material dispersion, Wave-guide dispersion, Polarization mode dispersion, Intermodal dispersion, pulse broadening. Measurements: Optical Time Domain Reflectometer (OTDR) and its uses - Interferometric method to measure fiber refractive index profile.

**MODULE III OPTICAL FIBERS FABRICATIONS & CONNECTORS L: 6 T: 0 P: 3**

Fiber fabrication: steps for optical fibers fabrication - methods to make the preform: outside vapor phase oxidation, vapor phase axial deposition, modified chemical vapor deposition, plasma-activated chemical vapor deposition - types of fiber optic cables - fiber splices - fiber connectors and couplers - lensing schemes for coupling improvements.

**MODULE IV OPTICAL SOURCES AND DETECTORS L: 6 T: 0 P: 3**

Optical Sources: Direct and indirect band gaps, LED-LED structures, surface emitting LED-Edge emitting LED-quantum efficiency and LED power-light source materials-modulation of LED. LASER diodes- modes and threshold conditions - Rate equations- external quantum efficiency Optical Detectors – Pin photodiodes - Avalanche photodiodes.

**MODULE V OPTICAL AMPLIFIERS AND NETWORKS L: 6 T: 0 P: 3**

Optical amplifiers - Semiconductor optical amplifiers - Erbium-doped fiber amplifiers - Optical networks: Basic networks - SONET / SDH - Broadcast and select WDM networks - Wavelength routed networks - Ultra high capacity networks - Introduction to Li-Fi.

**L-30; P – 15; TOTAL HOURS - 45**

**TEXT BOOKS:**

1. Gerd Keiser, "Optical fiber Communications", McGraw Hill Inc. Company, Tokyo, 5th Edition, 2017.
2. John M. Senior, "Optical Fiber Communications", Prentice Hall International Ltd., London, 3rd Edition, 2010.
3. Govind P. Agrawal, "Fiber Optic Communication Systems", John Wiley & Sons Inc., New York, 3rd Edition, 2007.

**REFERENCES:**

1. Fiber optic communication – Joseph C Palais: 4th Edition, Pearson Education.
2. Allen H. Cherin, "An Introduction to Optical Fibers", Mc Graw Hill Inc., Tokyo, 1995.

**EXPERIMENTS:**

1. To measure the different optical fiber's numerical aperture (NA).
2. Measuring optical power attenuation in plastic optical fiber.
3. Measuring optical power bending and coupling loss in plastic optical fiber.
4. To check the VI characteristic of LED.
5. Characteristics of LASER Diode.
6. Characteristics of APD
7. Describe the operational characteristics and parameters of the Photodiode used as photo detector in fiber optic system.

**COURSE OUTCOMES:**

- CO1:** Understand the structure, working principle, and classification of optical fiber.
- CO2:** Analyze the transmission characteristics of optical fibers, such as attenuation, scattering, dispersion.
- CO3:** Explain the materials, fabrication process, and design aspects of optical fiber cables and connectors, including splicing and lensing schemes.
- CO4:** Compare different optical sources and detectors like LEDs, laser diodes, photodetectors, and understand their noise, response characteristics, and junction structures.
- CO5:** Analyze the structure and functionality of optical amplifiers and networks.

**Board of Studies (BoS):**

15<sup>th</sup> BoS of Physics Department held on  
18/07/2025

**Academic Council:**

24<sup>th</sup> AC held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
<b>CO1</b>	H	M	H	L	M	L	H	H	M	H
<b>CO2</b>	H	H	H	H	H	L	H	H	M	H
<b>CO3</b>	H	M	H	H	H	M	L	H	H	H
<b>CO4</b>	H	H	H	H	H	M	M	H	M	M
<b>CO5</b>	H	H	H	H	H	L	H	H	H	M

\* Legend: L – Low (1), M – Medium (2), H – High (3).

**SDG 4:** Ensuring inclusive and equitable quality education for all persons and promote lifelong learning opportunities.

Statement : The modules and topics mentioned in this course are designed to ensure all inclusive and thorough education with equity to all persons and promote learning opportunities at all times.

M.Sc	Physics	Regulations 2025			
<b>PHFY 201</b>	<b>FERROELECTRIC MATERIALS AND DEVICES</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>SDG: 4</b>		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

### **COURSE OBJECTIVES:**

- COB1:** To introduce the fundamental concepts of dielectric behavior and ferroelectricity
- COB2:** To develop a theoretical understanding of ferroelectric materials
- COB3:** To provide knowledge on material processing techniques for ferroelectric materials
- COB4:** To explore the application of ferroelectric materials and pyroelectric devices
- COB5:** To examine the role of piezoelectric materials in modern sensors and actuators

### **MODULE I INTRODUCTION TO FERROELECTRICS L: 9 T: 0 P: 0**

Maxwell equations – Polarization – Macroscopic electric field – Local electric field at an atom – Dielectric constant and polarizability – Structural phase transitions – Displacive transitions – Soft optical phonons – Landau theory of the phase transition– Second order transition – First order transition – Antiferroelectricity – Ferroelectric domains – Optical ceramics.

### **MODULE II THEORY OF FERROELECTRICS L: 9 T: 0 P: 0**

Ferroelectricity, piezoelectricity and pyroelectricity – definitions – classification of ferroelectrics – oxygen octahedral and order – disorder ferroelectronics. Characteristics of typical ferroelectrics, barium titanate, potassium dihydrogen phosphate and triglycine sulphate – applications of ferroelectrics. Theories of ferroelectrics – dipole theory of ferroelectrics– first order and second order transitions – ferroelectric domains.

### **MODULE III FERROELECTRIC MATERIALS AND PROCESSING L: 9 T: 0 P: 0**

Common ferroelectric materials: BaTiO<sub>3</sub>, PZT, PVDF, BFO, KNN- Thin films vs. bulk materials- Synthesis techniques: solid-state reaction, sol-gel, sputtering, PLD, MOCVD- Doping and compositional tuning- Structure-property correlations- Characterization techniques: XRD, SEM, PFM, dielectric spectroscopy

**MODULE IV FERROELECTRIC MATERIALS FOR L: 9 T: 0 P: 0**  
**CAPACITIVE AND PYROELECTRIC DEVICES**

Ceramic capacitors. Chip capacitors. Hybrid substrate– High permittivity – Diffuse phase transition – Dielectric relaxation -IK dielectric materials. Ferroelectric memory devices: DRAM – Ferroelectric DRAM Pyroelectric devices: Pyroelectric materials – pyroelectric effect – responsivity – figures of merit. Temperature / infrared light sensors.

**MODULE V PIEZOELECTRICITY IN MODERN DEVICES L: 9 T: 0 P: 0**

Piezoelectric materials and properties – Figures of Merit. – Single crystal – polycrystalline materials - relaxer ferroelectrics polymers – composites thin film- Pressure sensors, accelerometers, gyroscopes. Piezoelectric vibrators – ultrasonic transducers – Resonators/filters. Piezoelectric transformers, Piezoelectric actuators.

**L - 45; TOTAL HOURS - 45**

**TEXT BOOKS:**

1. Kenji Uchino, "Ferroelectric Devices", Marcel Dekker, INC, 2000.
2. Gerhard R, "Electrets", Vol 2, Laplacian Press, 2000.

**REFERENCES:**

1. Moulson A L and Herberh J M, "Electroceramics – Materials properties and Applications", Chapman & Hall, 2000.
2. Lines M E and Glass A M, "Principles and Applications of Ferroelectrics and Related Materials", Clarendon Press, 1977.
3. Jack C Burfoot, "Ferroelectrics – Introduction to the Physical Principles", D Van Nostrand Co., 1967.

**COURSE OUTCOMES:**

- CO1:** Understand the principles of ferroelectric materials.
- CO2:** Comprehend and analyze the basic theory behind the concept of ferroelectricity
- CO3:** Assimilate the concept of dielectric materials and apply its applications.
- CO4:** Comprehensively grasp ideas related to ferroelectric materials, devices and applications
- CO5:** Analyze the structure and functionality of optical amplifiers and networks.

**Board of Studies (BoS):**

15<sup>th</sup> BoS of Physics Department held on  
18/07/2025

**Academic Council:**

24<sup>th</sup> AC held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	H	M	L	L	M	M	M	H	M	H
CO2	H	M	M	L	L	M	L	H	M	H
CO3	H	M	M	L	L	L	L	H	H	H
CO4	H	M	M	L	M	M	M	H	M	M
CO5	H	M	M	L	M	M	M	H	H	M

\* Legend: L – Low (1), M – Medium (2), H – High (3).

**SDG 4:** Ensuring inclusive and equitable quality education for all persons and promote lifelong learning opportunities.

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<b>PHFY 202</b>	<b>INTRODUCTION TO NONLINEAR DYNAMICS</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>SDG: 4</b>		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**COURSE OBJECTIVES:**

- COB1: To provide a comprehensive foundation in the fundamental principles linear and nonlinear systems.
- COB2: To equip students with a solid understanding of fixed points and stability analysis
- COB3: To introduce students to the concept of bifurcation and chaos.
- COB4: To understand finite dimensional integrable nonlinear dynamical systems.
- COB5: To learn about solitons and integrability.

**MODULE I LINEAR AND NONLINEAR SYSTEMS L:09 T:0 P: 0**

Linear and nonlinear forces – Nonlinear dynamical systems – Effects of nonlinearity – Phase space – Liouville theorem – Solution of damped and forced linear oscillator – Resonance phenomenon – Duffing oscillator – Jump phenomenon.

**MODULE II FIXED POINTS AND STABILITY ANALYSIS L:09 T:0 P: 0**

Stable and unstable fixed points – Classification of fixed points in first and second order systems – Limit cycle motion – Bifurcations: Saddle node, Pitchfork, Transcritical and Hopf bifurcations.

**MODULE III BIFURCATION AND CHAOS L:09 T:0 P: 0**

Logistic map : Stability of period – 1 and 2 fixed points – period doubling phenomenon – Onset of chaos – Bifurcation diagram – Different routes to chaos : Period doubling route, quasiperiodic route and intermittency route – Necessary conditions for chaos.

**MODULE IV FINITE DIMENSIONAL INTEGRABLE NONLINEAR DYNAMICAL SYSTEMS L:09 T:0 P: 0**

The notion of integrability – Hamiltonian systems - Complete integrability: Painlevé analysis: Classification of singular points – Nonlinear ordinary differential equations – Lorentz Equations - Symmetries and integrability (elementary ideas) – Noether's Theorem - integrable discrete systems (brief introduction).

**MODULE V SOLITON AND INTEGRABILITY L:09 T:0 P: 0**

Complete Integrability of finite dimensional systems – Painlevé analysis to detect Integrability - Linear and nonlinear waves – Conoidal and solitary waves \_ John Scott

Russel's observation of solitary wave – K-dV equation – Fermi – Pasta Ulam Problem – Numerical experiment of Zabusky and Kruskal – Soliton – Lax pair – Inverse Scattering Transform method for K-dV equation – Other soliton equations – Applications.

**L – 45; Total Hours: 45**

**TEXT BOOKS:**

1. M. Lakshmanan and S.Rajasekar, Nonlinear Dynamics: Integrability Chaos and Patterns (Springer – Verlag, Berlin, 2003).
2. H. Strogatz, Nonlinear dynamics and Chaos: With Applications to Physics, Biology, Chemistry, and Engineering, (Cambridge University Press, Cambridge, 1994).
3. M. J. Ablowitz and P. A. Clarkson, Solitons, Nonlinear Evolution Equation and Inverse Scattering (Cambridge University Press, Cambridge, 1991).

**REFERENCES:**

1. M. Lakshmanan and S.Rajasekar, Nonlinear Dynamics: Integrability Chaos and Patterns (Springer – Verlag, Berlin, 2003).
2. H. Strogatz, Nonlinear dynamics and Chaos: With Applications to Physics, Biology, Chemistry, and Engineering, (Cambridge University Press, Cambridge, 1994).
3. Robert C. Hilborn, Chaos and Nonlinear dynamics, (Oxford University Press, 1995).
4. M. J. Ablowitz and P. A. Clarkson, Solitons, Nonlinear Evolution Equation and Inverse Scattering (Cambridge University Press, Cambridge, 1991).
5. Yuri S. Kivshar, G. Agrawal, Nonlinear Fiber Optical Solitons: From fiber to Photonic Crystals (San Diego: Academic, 2003).

**COURSE OUTCOMES:**

- CO1:** Demonstrate a thorough understanding of the fundamental principles of linear and nonlinear systems.
- CO2:** Apply key concepts such as fixed points and stability analysis
- CO3:** Discussion on bifurcation and chaos
- CO4:** Understand the core concepts of various finite dimensional integrable nonlinear dynamical systems.
- CO5:** Discussion on Soliton and Integrability.

**Board of Studies (BoS):****Academic Council:**

15<sup>th</sup> BoS of Physics Department held  
on 18/07/2025

24<sup>th</sup> AC held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	M	L	L	L	L	L	L	H	M	H
CO2	M	M	L	L	L	H	M	H	M	H
CO3	M	L	L	L	L	L	L	H	H	H
CO4	L	M	M	H	L	L	L	H	M	M
CO5	L	L	L	L	L	L	L	H	H	M

\* Legend: L – Low (1), M – Medium (2), H – High (3).

**SDG 4:** Ensuring inclusive and equitable quality education for all persons and promote lifelong learning opportunities.

**Statement:**

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M.Sc	Physics	Regulations 2025			
<b>PHFY 203</b>	<b>NUMERICAL METHODS AND</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>SDG : 4</b>	<b>PROGRAMMING</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

### **COURSE OBJECTIVES:**

- COB1:** To understand the basic errors occurring in numerical methods.
- COB2:** To have an idea about solution of Algebraic and Transcendental Equations.
- COB3:** To know about the interpolation concepts.
- COB4:** To familiarize the numerical differentiation and integration equations.
- COB5:** To learn about the R programming and its applications in the research areas.

### **MODULE I ERRORS AND DATA FITTING L:09 T:0 P: 0**

Definitions and sources of numerical errors: truncation, round-off - Error propagation and significant digits - General error formula - Least squares fitting - Curve fitting: Linear, Polynomial, and Exponential.

Applications: Error propagation in experimental data - Fitting decay curves (radioactivity), blackbody radiation curves.

### **MODULE II SOLUTION OF ALGEBRAIC & TRANSCENDENTAL EQUATIONS L:09 T:0 P: 0**

Root-finding methods: Bisection, False Position, Newton-Raphson - System of linear equations: Direct: Gauss elimination, Gauss-Jordan - Iterative: Jacobi, Gauss-Seidel.

Applications: Solving Schrödinger's eigenvalue problem numerically - Calculating energy levels in potential wells - Solving circuit equations in electrical networks

### **MODULE III INTERPOLATION TECHNIQUES L:09 T:0 P: 0**

Finite differences - Newton's Forward and Backward Interpolation - Central difference formulas (Stirling, Gauss) - Divided differences - Lagrange interpolation.

Applications: Interpolating values from tabulated thermodynamic data - Finding missing data in spectroscopic datasets.

### **MODULE IV NUMERICAL DIFFERENTIATION AND INTEGRATION L:09 T:0 P: 0**

Forward and backward difference methods - Cubic spline interpolation - Trapezoidal and Simpson's rules - Romberg and Gaussian integration - Newton-Cotes formulas.

Applications: Calculating work from force-displacement data - Numerical integration of

Planck's radiation law - Finding maxima/minima in quantum mechanical systems.

**MODULE V IMPLEMENTATION USING R PROGRAMMING L:09 T:0 P: 0**

Introduction to R: data types, control structures, functions - Input/output, file handling - Plotting and visualization - Implementation of methods from Modules I–IV - Physics-based case studies in R.

**L – 45; Total Hours: 45**

**TEXTBOOKS:**

1. Kandasamy, P., Thilagavathy, K., and Gunavathy, K., *Numerical Methods*, S. Chand & Co., 2006.
2. Grewal, B.S., and Grewal, J.S., *Numerical Methods in Engineering and Science*, Khanna Publishers, 2015.

**REFERENCES:**

1. Sastry, S.S., *Introductory Methods of Numerical Analysis*, 5th Edition, Prentice-Hall of India, 2012.
2. Gerald, C.F., and Wheatley, P.O., *Applied Numerical Analysis*, 7th Edition, Addison-Wesley, 2003.
3. Matloff, N., *The Art of R Programming*, No Starch Press, 2011.
4. Venables, W.N., and Smith, D.M., *An Introduction to R*, R Foundation, Latest Edition (Free online manual).

**COURSE OUTCOMES:**

- CO1:** find and eliminate the errors in numerical methods.
- CO2:** get deeper insights towards various numerical methods to solve the algebraic and transcendental equations.
- CO3:** explain the interpolation concepts.
- CO4:** solve the differentiation and integration equations by numerical techniques.
- CO5:** understand the R programming and its applications in the research areas.

**Board of Studies (BoS) :**

15<sup>th</sup> BoS of Physics Department held on  
18/07/2025

**Academic Council:**

24<sup>th</sup> AC held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	H	L	H	H	L	L	L	H	M	H
CO2	M	M	M	H	L	M	L	H	M	H
CO3	M	M	H	H	L	L	H	H	H	H
CO4	M	M	M	M	H	L	H	H	M	M
CO5	M	L	L	L	H	H	L	H	H	M

\* Legend: L – Low (1), M – Medium (2), H – High (3).

**SDG 4** : Ensuring inclusive and equitable quality education for all persons and promote lifelong learning opportunities.

**Statement** : The modules and topics mentioned in this course are designed to ensure all inclusive and thorough education with equity to all persons and promote learning opportunities at all times.

<b>PHFY 204</b>	<b>NANOPHOTONIC DEVICES AND</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>SDG: 4</b>	<b>APPLICATIONS</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**COURSE OBJECTIVES:**

- COB1: To understand the fundamental principles and properties of nanophotonics and quantum structures.
- COB2: To explore the properties and applications of plasmonic nanostructures
- COB3: To introduce the concepts of quantum emitters and optical antennas, and examine their roles in controlling light emission,
- COB4: To understand the properties of photonic crystals and photonic media.
- COB5: To familiarize with nanophotonic techniques in bioimaging and optical manipulation

**MODULE I NANOPHOTONICS : FUNDAMENTALS AND L: 9 T: 0 P: 0 PROPERTIES**

Introduction to nanophotonics: scope and evolution, Review of classical optics and electromagnetic theory, Light-matter interaction at the nanoscale, Photons and Electrons: Similarities and Differences, Nanoscale Confinement of Electronic Interactions, Quantum-Confined Materials: Quantum Wells, Quantum Wires, Quantum Dots, Manifestations of Quantum Confinement: Optical Properties, Nonlinear Optical Properties, Quantum-Confined Stark Effect; Dielectric Confinement Effect, Core-Shells, Quantum-Confined Structures as Lasing Media.

**MODULE II PLASMONICS AND EXCITATION DYNAMICS L: 9 T: 0 P: 0**

Metallic Nanoparticles and Nanorods, Metallic Nanoshells, Local Field Enhancement, Subwavelength Aperture Plasmonics, Plasmonic Wave Guiding, Applications of Metallic Nanostructures, Radiative Decay Engineering, Surface plasmon polaritons at plane interfaces: Properties of surface plasmon polaritons, Thin-film surface plasmon polaritons, Excitation of surface plasmon polaritons, Surface plasmon sensors, Surface-enhanced Raman scattering, Nanostructure and Excited States, Rare-Earth Doped Nanostructures, Up-Converting Nanophores, Photon Avalanche, Quantum Cutting, Site Isolating Nanoparticles.

**MODULE III QUANTUM EMITTERS AND OPTICAL L: 9 T: 0 P: 0 ANTENNA**

Types of quantum emitters, Fluorescent molecules, Color centers in diamond, The

absorption cross-section, Single-photon emission by three-level systems, Steady-state analysis, Time-dependent analysis, Single molecules as probes for localized fields, Optical antennas: Significance, Optical antenna theory: Antenna parameters, Antenna-coupled light-matter interactions Coupled-dipole antennas, Quantum emitter coupled to an antenna, Quantum yield enhancement.

#### **MODULE IV PHOTONIC CRYSTALS AND PHOTONIC MEDIA L: 9 T: 0 P: 0**

Photonic Crystals : Basics Concepts, Theoretical Modeling of Photonic Crystals, Features of Photonic Crystals, Methods of Fabrication, Photonic Crystal Optical Circuitry, Nonlinear Photonic Crystals, Photonic Crystal Fibers (PCF), Photonic Crystals and Optical Communications, Nanocomposites: Nanocomposites as Photonic Media, Nanocomposite Waveguides, Optical cavity and Resonators, Random Lasers: Laser Paints, Local Field Enhancement, Nanocomposites for Optoelectronics, Polymer-Dispersed Liquid Crystals (PDLC)

#### **MODULE V BIOIMAGING TECHNIQUES AND OPTICAL FORCE SPECTROSCOPY L: 9 T: 0 P: 0**

Cells and their structure, Imaging techniques: **Light microscopy**, wide-field, laser scanning - confocal, multiphoton, fluorescence lifetime imaging, FRET imaging - Cellular Imaging - Imaging of soft and hard tissues and other biological structures, **Optical Force Spectroscopy**: Generation optical forces – Optical trapping and manipulation of single molecules and cells in optical confinement - Laser trapping and dissection for biological systems.

**L – 45; Total Hours: 45**

#### **TEXT BOOKS:**

1. Paras N. Prasad, Nanophotonics, Wiley-Interscience, 1<sup>st</sup> edition (2004).
2. Lukas Novotny, Bert Hecht, Principles of Nano-Optics, 2<sup>nd</sup> Edition, Cambridge Univ Press; (2012).

#### **REFERENCES:**

1. Sergey V. Gaponenko, Introduction to Nanophotonics, Cambridge University Press; 1st edition; Cambridge University Press (2010).
2. Paras N. Prasad, Introduction to Biophotonics, Wiley-Interscience; 1<sup>st</sup> edition (2003).
3. Philip H. Jones, Onofrio M. Maragò, Giovanni Volpe, Optical Tweezers:

Principles and Applications, Cambridge University Press, (2015).

4. Klaus D. Sattler, Handbook of Nanophysics: Nanoparticles and Quantum Dots, CRC Press; 1<sup>st</sup> edition (2020).
5. Sabu Thomas et al., Nanotechnology for Biomedical Applications, 1<sup>st</sup> Edition, Elsevier (2024).
6. Mansoor M. Amiji, Nanotechnology for Cancer Therapy, CRC Press; 1<sup>st</sup> edition (2006).

#### **COURSE OUTCOMES:**

- CO1:** Describe the fundamental concepts of nanophotonics
- CO2:** Analyze the optical behavior of plasmonic nanostructures
- CO3:** Apply the principles of quantum emitters and optical antennas
- CO4:** Evaluate the design, fabrication, and functionality of photonic crystals and nanocomposite photonic media.
- CO5:** Explain the ability to interpret advanced bioimaging data and use optical force tools in biological systems.

#### **Board of Studies (BoS):**

15<sup>th</sup> BoS of Physics Department held on 18/07/2025

#### **Academic Council:**

24<sup>th</sup> AC held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	L	L	H	H	L	M	M	H	M	H
CO2	H	M	M	M	H	H	M	H	M	H
CO3	H	H	H	M	M	M	H	H	H	H
CO4	H	H	M	M	M	M	M	H	M	M
CO5	H	M	M	M	M	M	M	H	H	M

\* Legend: L – Low (1), M – Medium (2), H – High (3).

**SDG 4 :** Ensuring inclusive and equitable quality education for all persons and promote lifelong learning opportunities.

**Statement :** The modules and topics mentioned in this course are designed to ensure all inclusive and thorough education with equity to all persons and promote learning opportunities at all times.

<b>PHFY 205</b>	<b>OPTICAL MODULATORS AND DEVICES</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>SDG: 4</b>		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**COURSE OBJECTIVES:**

- COB1:** To understand the interaction of light with various materials.
- COB2:** To analyze the properties and behavior of anisotropic crystals and the principles of birefringence.
- COB3:** To understand about electro-optic, magneto-optic, and acousto-optic effects and their applications in modulation.
- COB4:** To analyze various optical modulation techniques and devices such as EO modulators, deflectors, and spectrum analyzers.
- COB5:** To explore the fundamentals of nonlinear optical effects and their applications in photonic devices.

**MODULE I ELECTROMAGNETIC WAVE INTERACTIONS L: 9 T:0 P: 0**

Nature of light and polarization – interaction of light with materials – polarization – production and detection of polarized lights – Anisotropic crystals – calcite crystal – optic axis – principal section – principal plane - double refraction – electromagnetic theory on double refraction – optical indicatrix - phase difference between E-ray and O-ray.

**MODULE II INTRODUCTION TO ELECTRO-OPTICS L: 9 T:0 P: 0**

Overview of electro- optics – uniaxial crystals – biaxial crystals -Wave equation in isotropic material and anisotropic materials – index ellipsoid – propagation in uniaxial and biaxial crystals – birefringence - introduction to electro-optic (EO) effects – classification of EO materials – Properties of EO materials – Kerr effect – Pockel’s effect – electro-optic modulators – applications.

**MODULE III MAGNETO, PHOTO AND ACOUSTO OPTICS L: 9 T:0 P: 0**

Magneto-optic effect - magneto optic modulator – Cotton Mouton effect – Faraday effect – anisotropy induced by mechanical strain – photoelasticity – isoclinic and isochromatics -photo elastic bench - Acousto-optic (AO) effect - AO tunable filters - – Bragg diffraction of light by acoustic waves.

**MODULE IV MODULATORS L: 9 T:0 P: 0**

Electro-optic (EO) light modulators – electro-optic Fabry-Perot modulators – bistable EO devices - EO based beam deflection – Q - switching Design of Mach-Zehnder and

phase modulators- Electro-absorption modulators - Raman-Nath and Bragg diffraction, small and large angle - Bragg diffraction, acousto-optic modulator, deflector and spectrum analyzer.

**MODULE V NON LINEAR OPTICAL MATERIALS AND DEVICES L: 9 T:0 P: 0**

Origin of optical nonlinearities – second and third order optical non-linearities - Optical switching devices employing optical non-linearities - Photorefractive effect - Two beam coupling in Photorefractive materials – Four wave mixing in Photorefractive materials.

**L – 45; Total Hours: 45**

**TEXT BOOKS:**

1. B.E.A. Saleh and M.C. Teich, Fundamentals of Photonic, Wiley (2012).
2. Robert W. Boyd, Nonlinear Optics, Academic Press (2008).
3. Ghatak & Thyagarajan, Optical Electronics (2017).

**REFERENCES:**

1. Munn R W and Ironsid C N, "Non - Linear Optical Materials", Blackie Academic & Professional, Glassgow, (1993).
2. Kochner W, "Solid State Laser Engineering", Springer-Verlag, New York, (2010).
3. Yariv A, "Quantum Electronics", John Wiley & Sons,( 1988).
4. Ivan P Kaminov, " Introduction to Electro-Optic Devices", Academic press, New York, (1974).

**COURSE OUTCOMES:**

- CO1:** Explain the fundamental properties of light.
- CO2:** Analyze the propagation of light in isotropic and anisotropic crystals.
- CO3:** Describe and compare the electro-optic effects (Kerr and Pockels) and their use in designing modulators.
- CO4:** Illustrate the principles of magneto-optic and acousto-optic interactions and their application in optical devices
- CO5:** Design and evaluate optical modulators and switching devices using nonlinear optical materials.

**Board of Studies (BoS):**

15<sup>th</sup> BoS of Physics Department held on 18/07/2025

**Academic Council:**

24<sup>th</sup> AC held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	H	L	H	H	L	L	M	H	H	H
CO2	L	L	L	L	L	H	M	H	M	M
CO3	M	M	H	M	M	L	H	H	H	H
CO4	L	L	H	H	M	M	M	M	M	M
CO5	M	H	H	M	M	L	H	H	H	M

\* Legend: L – Low (1), M – Medium (2), H – High (3).

**SDG 4:** Ensuring inclusive and equitable quality education for all persons and promote lifelong learning opportunities.

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M.Sc	Physics	Regulations 2025			
<b>PHFY 206</b>	<b>OPTOELECTRONIC DEVICES</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>SDG: 4</b>		<b>2</b>	<b>0</b>	<b>1</b>	<b>3</b>

### **COURSE OBJECTIVES:**

- COB1:** Make the students learn about the fundamentals of the basic physics behind optoelectronic sources.
- COB2:** Acquire in depth understanding of photodetectors and displays.
- COB3:** Enable the students to get knowledge on various types of optical modulators.
- COB4:** Explore optical imaging systems using CCD and CMOS sensors for scientific and industrial imaging.
- COB5:** Provide a comprehensive understanding of the modern applications of optoelectronic systems.

### **MODULE I OPTOELECTRONIC SOURCE L: 6 T:0 P: 03**

Basics of reflection, refraction, transmission and absorption of light radiation, Light-Emitting Diodes: types, structure - homo/heterojunctions LEDs - characteristics - White LEDs; Semiconductor Lasers, Optical processes in semiconductor lasers- power and efficiency, Applications : LEDs and laser diodes, optoisolators - optical processes in organic semiconductor devices –excitonic state.

### **MODULE II OPTOELECTRONIC DETECTORS L: 6 T:0 P: 03**

Idea of light detectors, Natural and quantum specialized light detectors, Types of special light detector – thermal and quantum detectors, Types of quantum photodetectors- photo resistive, photovoltaic and photoelectric cell, photomultiplier tube, Phototransistors, Solar cells: different generations, materials and fabrications methods, PIN photodiodes, Avalanche photodiodes, Important characteristics of light detectors: spectral response, responsivity, quantum efficiency, signal-to-noise ratio, material used for photodetectors.

### **MODULE III OPTICAL MODULATORS L: 6 T:0 P: 03**

Modulation Techniques: Electro-optic modulators: Pockels effect, Kerr Effect, Intensity-dependent refractive index, Nonlinear optical effects in Kerr media, Acousto-optic modulators: Bragg and Raman-Nath types-Magneto-optic modulators-Electro-absorption modulators- Applications in ultrafast optical switching and signal processing- Modulator Configurations: Mach-Zehnder interferometers-Directional couplers-Ring resonators.

**MODULE IV OPTICAL COMMUNICATION AND IMAGING L: 6 T:0 P: 03**

Basics of optical fiber communication systems-Optical transmitters and receivers-Wavelength division multiplexing (WDM)-Imaging systems: CCD, CMOS sensors-Bioimaging and sensing applications using optoelectronic devices-Emerging trends: quantum dot LEDs, perovskite photodetectors, Li-Fi

**MODULE V MULTIDISCIPLINARY APPLICATIONS AND EMERGING MATERIALS L: 6 T:0 P: 03**

Next-Gen Communication Systems: Terabit-speed optical interconnects- Silicon photonics-Integrated photonic circuits. Neuromorphic & Quantum Computing: Optoelectronic synapses-Photonic qubits and quantum light sources-optical logic gates. Biomedical & Wearable Tech: Flexible optoelectronic sensors-Implantable photonic devices-Wearable OLED displays- smart textiles. Emerging Materials & Devices: Photonic crystals and metamaterials.

**LIST OF EXPERMENTS**

To study and plot the characteristics of following Opto-Electronic devices

1. Solar cell Characteristics of LEDs
2. Characteristics of LASER diode
3. Characteristics of Photodiodes
4. Determination of electro-optic coefficient using KERR modulator.
5. To construct and characterize a QD-based LED.
6. Characteristics of Diodes
7. Model QD-based nonlinear optical logic gates using MATLAB.

**L – 30; P – 15; Total Hours- 45**

**TEXT BOOKS:**

1. Optoelectronics: An Introduction John Wilson & John Hawkes 2018, Pearson Education
2. Semiconductor Optoelectronic Devices Pallab Bhattacharya 1996, Prentice Hall
3. Fundamentals of Photonics Bahaa E. A. Saleh & Malvin Carl Teich 2019 (2nd Edition), Wiley
4. Optoelectronics and Photonics: Principles and Practices Safa O. Kasap 2013 (2nd Edition), Pearson
5. Handbook of Optoelectronics: Concepts, Devices, and Techniques Edited by John P. Dakin & Robert G. W. Brown 2017 (2nd Edition), CRC Press

**REFERENCES:**

1. Bhattacharya, P., 2007. Semiconductor optoelectronic devices. Prentice-Hall, Inc..
2. Khare, R.P., 2004. Fiber optics and optoelectronics.
3. Kasap, S.O., 2013. *Optoelectronics and photonics* (Vol. 218). Pearson Education UK.
4. Introduction of Optical Electronics: K.A. Jones (2012), Harper and Row.

**COURSE OUTCOMES:**

- CO1:** understand physical principles governing the operation of optoelectronic sources
- CO2:** explore the characteristics, types, and applications of photodetectors and flat-panel display technologies.
- CO3:** compare the operating mechanisms and classifications of optical modulators including electro-optic and acousto-optic devices.
- CO4:** access to modern communication and sensing applications
- CO5:** analyze and evaluate real-world applications of optoelectronic devices in emerging quantum technologies.

**Board of Studies (BoS):**

15<sup>th</sup> Meeting of BoS was held on  
18/07/2025

**Academic Council:**

24<sup>th</sup> AC held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO 2	PSO3
<b>CO1</b>	H	H	H	H	H	H	H	M	H	M
<b>CO2</b>	H	H	H	H	H	L	H	L	H	H
<b>CO3</b>	H	H	H	H	H	H	H	L	H	H
<b>CO4</b>	H	H	H	L	H	H	H	H	H	H

\* Legend: L – Low (1), M – Medium (2), H – High (3).

**SDG 4:** Ensuring inclusive and equitable quality education for all persons and promote lifelong learning opportunities.

**Statement:** The modules and topics mentioned in this course are designed to ensure all inclusive and thorough education with equity to all persons and promote learning opportunities at all.

M.Sc	Physics	Regulations 2025			
<b>PHFY 207</b>	<b>PHOTONIC MATERIALS AND DEVICES</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>SDG: 4</b>		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**COURSE OBJECTIVES:**

- COB1:** To impart knowledge on photonic devices by going over the fundamentals of semiconductor physics and optical processes in semiconductors.
- COB2:** To study about various optical process in semiconductors.
- COB3:** To explore device fabrication techniques using semiconductor materials.
- COB4:** To gain knowledge on characteristics of photonic devices.
- COB5:** To gain knowledge on display devices and materials.

**MODULE I SEMICONDUCTING MATERIALS L: 7 T: 0 P:0**

Band gaps - density of states – Junction Theory-PN junction- current density across junctions, injection efficiency, Quasi-fermi level and high-level injection, graded junctions- heterojunction, double heterojunction -materials - optical and electronic properties- Quantum wells and quantum dots – heterostructures- superlattices.

**MODULE II OPTICAL PROCESSES IN SEMICONDUCTORS L:10 T:0 P:0**

Optical properties of semiconductors- Radiative and non-radiative recombination, band to band recombination, exciton absorption, donor- acceptor and impurity band absorption, long wavelength absorption, Relation between absorption and emission – effect of electric field on absorption – absorption in quantum wells and the quantum-confined Stark effect – Kramer-Kronig relations – radiation in semiconductors – deep level transitions – auger recombination – Luminescence from quantum wells – measurement of absorption and luminescence spectra – time resolved photoluminescence.

**MODULE III SEMICONDUCTOR DEVICE FABRICATION L: 10 T:0 P:0**

Types of photonic materials –III-V compound-II-VI compounds- Materials Growth & Fabrication Growth of optoelectronics materials by MBE, MOCVD, Plasma CVD, photochemical deposition. Epitaxy, interfaces and junctions (advantages/disadvantages of growth methods on interface quality, interdiffusion and doping- Quantum wells and bandgap engineering (examples of structures)-post-growth processing- Photolithography-different methodologies – patterning - fabrication of semiconductor

devices.

**MODULE IV PHOTONIC DEVICES****L:10 T:0 P:0**

Opto-electronic detectors-Thermal detectors, Photoconductive detectors – junction photodiodes, P-I-N photodetector- quantum efficiency and frequency response, Silicon photodiodes- performance characteristics APD- design issues and band width, Phototransistors, Modulated barrier photodiodes, Schottky barrier PD, Metal Semiconductor photodetectors, MSM PD, Solar cells.

**MODULE V DISPLAY DEVICES AND MATERIALS****L:8 T:0 P:0**

Liquid Crystals-nematic, smectic and cholesteric phases: director and order parameter- display devices. LEDs and OLED – Basics, Structure and Operation - Polymeric and Organic materials: Hole transport materials- Amines, PPV derivatives, poly phenylene derivatives, polythiophenes. Electron transport materials – Metal chelates, oxadiazoles, PPV; Electrode materials – ITO, Metals, metal alloys; Electro-optic materials – Emissive displays, Reflective displays, Transmissive display.

**L – 45; Total Hours: 45****TEXT BOOKS:**

1. P. Bhattacharya, "Semiconductor optoelectronic devices", Prentice-Hall India, New Delhi, 2003.
2. B.E.A. Saleh and M.C. Teich., "Fundamentals of photonics", John Wiley., New York, 1991.
3. Organic Electroluminescent materials and Devices, S. Miyata and H.M. Nalwa, Gordon and Breach Publishers, 1997.

**REFERENCES:**

1. J. Singh, "Optoelectronics: An introduction to materials and devices", Mc-Graw-Hill Co., New York, 1996.
2. S.O. Kasap, "Optoelectronics and photonics: Principles and practices", Prentice-Hall, New York, 2001.
3. T.P. Pearsall, "Photonics essentials: An introduction to experiments", Mc-Graw-Hill Professional, New York, 2002.
4. Ajoy Ghatak and K Thyagarajan, "An Introduction on Fibre Optics", Cambridge University Press, 2012.
5. Hand book of organic electronics and photonics, Vol.1-3, Hari Singh Nalwa, American Scientific publishers, 2006.

**COURSE OUTCOMES:**

- CO1:** analyze the optical processes in semiconductors.
- CO2:** understand the properties of a photonic materials.
- CO3:** get deeper insights into the photonic devices and its fabrication techniques.
- CO4:** explore about the characteristics of photonic devices
- CO5:** understand about the displays and materials used in displays.

**Board of Studies (BoS):**

15<sup>th</sup> BoS of Physics Department held on  
18/07/2025

**Academic Council:**

24<sup>th</sup> AC held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	H	M	L	L	M	M	M	H	M	H
CO2	H	M	M	H	L	M	L	M	M	H
CO3	H	M	M	L	L	L	L	H	M	M
CO4	H	M	M	M	M	M	M	M	H	M
CO5	H	M	M	L	M	M	M	H	H	H

\* Legend: L – Low (1), M – Medium (2), H – High (3).

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M.Sc	Physics	Regulations 2025			
<b>PHFY 208</b>	<b>ADVANCED NON-DESTRUCTIVE TESTING</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>SDG: 4</b>		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**COURSE OBJECTIVES:**

- COB1:** Acquire the knowledge about acoustic emission method and its interpretation for defect identification.
- COB2:** Gain the knowledge about the thermography method to find the defects and its application in industries.
- COB3:** Demonstrate an understanding of ultrasonic guided waves and EMAT technique, its application in industry to evaluate the defects.
- COB4:** Understand the principle of leak testing technique to ensure quality of materials.
- COB5:** Expose the students to understand strain measurement, optical NDT and its importance in industries.

**MODULE I ACOUSTIC EMISSION INSPECTION L: 8 T: 0 P:0**

Principles and Theory – Signal Propagation – Physical Considerations – The AE Process Chain - Time Considerations – AE Parameters –The AE Measurement Chain – Types of displays – Noise – Location calculation and Clustering – Advantages – Limitations – Relationship to other test methods - inspection of pressure vessels/welds/composite materials – AE testing during grinding– pipelines – steam turbines – AE location of faults in power transformers.

**MODULE II THERMOGRAPHIC NDE L:10 T:0 P:0**

Introduction and fundamentals to infrared and thermal testing – Heat transfer – Active and passive techniques – Lock in and pulse thermography – Contact and non-contact thermal inspection methods – Heat sensitive paints – Heat sensitive papers – thermally quenched phosphors liquid crystals –techniques for applying liquid crystals – other temperature sensitive coatings – Inspection methods – Infrared radiation and infrared detectors – thermo mechanical behavior of materials – IR imaging in aerospace applications, electronic components, Honey comb and sandwich structures – Case studies

**MODULE III ULTRASONIC GUIDED WAVES L: 9 T:0 P:0**

Types of guided waves – Generation of guided waves – Plate theory – Rayleigh-Lamb Equation, Guided waves in Plates, Pipes and rods – Wave structure analysis – Dispersion curves –Modes in guided waves – Air coupled ultrasonic guided waves –

advantages and limitations – Applications, few case studies.

*Electro Magnetic Acoustic Transducer (EMAT)*-Basic principles – types of coil and design – Generation and defect detection of guided waves using EMATS- - advantages and limitations – Applications- case studies

#### **MODULE IV LEAK TESTING**

**L:10 T:0 P:0**

Introduction to leak testing– objectives – terminologies – measurement of leakage – Types of leak – Types of flow in leaks – Principles of Fluid dynamics – Leak Testing of Pressure Systems Without and with a Tracer Gas – Halogen diode leak testing – Helium mass spectrometer leak testing and subsystems – Choosing the Optimum Leak Testing Method – System response in leak testing – Measurement of Leak Rate Using Calibrated Leaks – Common errors in Leak testing- Leak testing for special applications-standards.

#### **MODULE V STRAIN MEASUREMENT AND OPTICAL NDT METHODS**

**L:8 T:0 P:0**

Principle - Types of strain gauges- bridge circuit for measurement – instrumentation, Laser Shearography, Holographic interferometry, Holographic shearing interferometry, Speckle pattern interferometry, Speckle pattern shearing interferometry, Digital image correlation, Microwave holography

**L – 45; Total Hours: 45**

#### **TEXT BOOKS:**

1. J. Prasad and C. G. K. Nair, Non-Destructive Test and Evaluation of Materials, Tata McGraw-Hill Education, 2nd edition (2011).
2. X. P. V. Maldague, Nondestructive evaluation of materials by infrared thermography, Springer-Verlag, 1st edition, (1993).
3. A. S. Paipetis, T. E. Matikas and D. G. Aggelis, Emerging Technologies in Non-Destructive Testing, CRC Press, (2012).
4. C. U. Grosse, Acoustic Emission Testing, Springer, (2008).
5. L. W. Schmerr, Fundamentals of Ultrasonic Phased Arrays, Springer, (2014)

#### **REFERENCES:**

1. L. W. Schmerr, Fundamentals of Ultrasonic Phased Arrays, Springer, (2014)
2. X. P.V. Maldague, Non-Destructive Testing Handbook; Infrared and Thermal Testing , Vol-3, series III, American Society for Non-Destructive Testing, 3rd edition (2001).
3. C. N. Jackson and N. Sherlock , Non-Destructive Testing Handbook; Leak Testing

, Vol – 1, series VI, American Society for Non-Destructive Testing, 3rd edition, (1998).

4. R. K.Miller and V.K.Hill, Non-Destructive Testing Handbook; Acoustic Emission Testing, Vol-6, series V, American Society for Non-Destructive Testing, 3rd edition, (2005).

### COURSE OUTCOMES:

- CO1:** will understand about acoustic emission method and its interpretation for defect identification
- CO2:** will able to gain the knowledge about the thermography for industrial application.
- CO3:** will able to apply the understanding of ultrasonic guided waves and EMAT technique in industry.
- CO4:** will demonstrate leak testing technique to ensure quality of materials
- CO5:** will acquire knowledge and understanding of strain measurement, optical NDT and its importance in industries.

### Board of Studies (BoS):

15<sup>th</sup> BoS of Physics Department held on 18/07/2025.

### Academic Council:

24<sup>th</sup> AC held on 26.08.2025

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	H	M	M	H	M	L	H	H	M	H
CO2	H	M	H	M	M	L	L	M	M	H
CO3	H	M	M	H	H	M	M	H	M	M
CO4	H	M	H	H	H	M	M	M	H	M
CO5	H	H	H	H	H	M	M	H	H	H

\* Legend: L – Low (1), M – Medium (2), H – High (3).

**SDG 4:** Ensuring inclusive and equitable quality education for all persons and promote lifelong learning opportunities.

### Statement:

The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and promote learning opportunities at all times.