# M.Sc., PHYSICS

## SYLLABUS

## Programme Code: 2PSPHY

**2026 -2028**

**SENGAMALA THAYAAR EDUCATIONAL TRUST**
**WOMEN'S COLLEGE (AUTONOMOUS)**
**(Affiliated to Bharathidasan University, Tiruchirappalli)**
**(Accredited by NAAC)**
**SUNDARAKOTTAI, MANNARGUDI - 614 016,**
**THIRUVARUR (Dt.), TAMIL NADU, INDIA.**

**SENGAMALA THAYAAR EDUCATIONAL TRUST WOMEN'S COLLEGE**
**(AUTONOMOUS)**
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**(Accredited by NAAC)**
**SUNDARAKKOTTAI, MANNARGUDI – 614 016.**
**TAMILNADU, INDIA.**

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# M.Sc., Physics

**CHOICE BASED CREDIT SYSTEM-LEARNING OUTCOME BASED**
**CURRICULUM FRAMEWORK (CBCS - LOCF)**
*(For the Candidate admitted in the academic year 2026-2027)*

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## CHOICE BASED CREDIT SYSTEM

The credit based semester system provides flexibility in designing curriculum and assigning credits based on the course content and hours of teaching. The choice based credit system provides a _cafeteria' type approach in which the students can take courses of their choice, learn at their own pace, undergo additional courses and acquire more than the required credits, and adopt an interdisciplinary approach to learning. Our College have has moved to CBCS and implemented the grading system.

## OUTCOME-BASED EDUCATION (OBE)

## LEARNING OUTCOME-BASED CURRICULUM FRAMEWORK (LOCF)

The fundamental premise underlying the learning outcomes-based approach to curriculum planning and development is that higher education qualifications are awarded on the basis of demonstrated achievement of outcomes (expressed in terms of knowledge, understanding, skills, attitudes and values) and academic standards expected of graduates of a programme of study. Learning outcomes specify what graduates completing a particular programme of study are expected to know, understand and be able to do at the end of their programme of study. The expected learning outcomes are used as reference points that would help formulate graduate attributes, qualification descriptors, programme learning outcomes and course learning outcomes which in turn will help in curriculum planning and development, and in the design, delivery and review of academic programmes. They provide general guidance for articulating the essential learnings associated with programmes of study and courses with in a programme, maintain national standards and international comparability of learning outcomes and academic standards to ensure global competitiveness, and to facilitate student/graduate mobility and provide higher education institutions an important point of reference for designing teaching- learning strategies, assessing student learning levels, and periodic review of programmes and academic standards.

**Some important aspects of the Outcome Based Education**

**Course:** is defined as a theory, practical or theory cum practical subject studied in a semester.

**Course Outcomes (COs):** are statements that describe significant and essential learning that learners have achieved and can reliably demonstrate at the end of a course. Generally three or more course outcomes may be specified for each course based on its Weightage.

**Programme:** is defined as the specialization or discipline of a Degree.

**Programme Outcomes (POs):** Programme outcomes are narrower statements that describe what students are expected to be able to do by the time of graduation. POs are expected to be aligned closely with Graduate Attributes.

**Programme Specific Outcomes (PSOs):** PSOs are what the students should be able to do at the time of graduation with reference to a specific discipline.

**Some important terminologies repeatedly used in LOCF.**

**Core Courses (CC)** A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course. These are the courses which provide basic understanding of their main discipline. In order to maintain a requisite standard certain core courses must be included in an academic program. This helps in providing a universal recognition to the said academic program.

**Discipline Centric Elective Courses (DCEC)** Elective course may be offered by the main discipline/subject of study is referred to as Discipline Centric Elective Course (DCEC). These courses offer the flexibility of selection of options from a pool of courses. These are considered specialized or advanced to that particular Programme and provide extensive exposure in the area chosen; these are also more applied in nature.

**Generic Elective Courses** An elective course chosen generally from an **unrelated discipline/subject,** with an intention to seek exposure is called a Generic Elective. Generic Elective courses are designed for the students of **other disciplines**. Thus, as per the CBCS policy, the students pursuing particular disciplines would have to opt Generic Elective courses offered by other disciplines, as per the basket of courses offered by the college. The scope of the Generic Elective Courses (GEC) is positively related to the diversity of disciplines in which programmes are being offered by the college.

**Non Major Elective Course (NMEC):** A student shall choose at least two Non-Major Elective Courses (NMEC) from outside his/her department.

**Skill Enhancement Courses (SECs)** These courses focus on developing skills or proficiencies in the student, and aim at providing hands-on training. Skill enhancement courses can be opted by the students of any other discipline, but are highly suitable for students pursuing their academic Programme. These courses may be chosen from a pool of courses designed to provide value-based and/or skill-based knowledge**.**

**Field Study/Industrial Visit/Case Study:** It has to be completed during the fifth semester of the degree Programme. Credit for this course will be entered in the fifth semester‘s marks statement.

**Internship:** Students must complete internship during summer holidays after the fourth semester. They have to submit a report of internship training with the necessary documents and have to appear for a viva-voce examination during fifth semester. Credit for internship will be entered in the fifth semester‘s mark statement.

**Extra Credit Courses:** In order to facilitate the students, gaining knowledge/skills by attending online courses MOOC, credits are awarded as extra credits, the extra credit are at three semesters after verifying the course completion certificates. According to the guidelines of UGC, the students are encouraged to avail this option of enriching their knowledge by enrolling themselves in the Massive Open Online Courses (MOOC) provided by various portals such as SWAYAM, NPTEL etc.

## EXAMINATION

### Continuous Internal Assessment (CIA):

### PG - Distribution of CIA Marks

**Passing Minimum: 50 %**

Assignments – 3 = 30%
Tests - 2 = 50%
Seminar =10 %
Attendance = 10 %

## Question Paper Pattern

**Part A**: includes two subsections
**Part A** 1 (10X1=10 marks)
One word question/ Fill in the blacks/ True or False/ Multiple Choice Questions
Two Questions from Each unit

**Part A 2**(5X2=10 marks)
Match the following
Short Answers
One question from each unit
**Total Marks - 20**

**Part B**: (5X4 =20 marks)
Paragraph Answers
Either/ or type, One Question from each unit

**Part C**: (10X3=30)
Essay Type Answers
Answer 3 out of 5 Questions
One Question from each unit

**Part A**: K1 Level
**Part B**: K2, K3 and K4 Level
**Part C**: K5 and K6 Level

**Knowledge levels for assessment of Outcomes based on Blooms Taxonomy**

| S.No. | Level | Parameter | Description |
|---|---|---|---|
| 1 | K1 | Knowledge/Remembering | It is the ability to remember the previously Learned |
| 2 | K2 | Comprehension/ Understanding | The learner explains ideas or concepts |
| 3 | K3 | Application/Applying | The learner uses information in a new way |
| 4 | K4 | Analysis/Analyzing | The learner distinguishes among different parts |
| 5 | K5 | Evaluation/Evaluating | The learner justifies a stand or decision |
| 6 | K6 | Synthesis/Creating | The learner creates a new product or point of View |

**WEIGHTAGE of K –LEVELS IN QUESTION PAPER**

| (Cognitive Level) K-LEVELS → | Lower Order Thinking | | | Higher Order Thinking | | | Total |
|---|---|---|---|---|---|---|---|
| | K1 | K2 | K3 | K4 | K5 | K6 | |
| **END SEMESTER EXAMINATIONS (ESE)** | 20 | 20 | | | 30 | | **70** |
| **Continuous Internal Assessment (CIA)** | 20 | 20 | | | 30 | | **70** |

## QUESTION PATTERN FOR END SEMESTER EXAMINATION /
## Continuous Internal Assessment

| SECTION | | MARKS |
|---|---|---|
| **SECTION – A1** (No choice, One Mark) **TWO** questions from each unit<br>**SECTION – A2** (No choice, Two Mark) **ONE** question from each unit | (10x1=10)<br>(5x2 = 10) | **20** |
| **SECTION –B** (Either/or type, 4-Marks) **ONE** question from each unit | (5x4 = 20) | **20** |
| **SECTION – C** (3 out of 5)(10 Marks) **ONE** question from each unit | (3x10 = 30) | **30** |
| **Total** | | **70** |

**BLUE PRINT OF QUESTION PAPER FOR END SEMESTER EXAMINATION**

**DURATION: 3.00 Hours.** **Max Mark :70**

| **K-LEVELS**<br>**SECTION** | **K1** | **K2** | **K3** | **K4** | **K5** | **K6** | **Total Marks** |
|---|---|---|---|---|---|---|---|
| **SECTION – A1**(One Mark, No choice) (10x1=10) | 10 | | | | | | **10** |
| **SECTION – A2** (2 -Marks, No choice) (5x2 = 10) | 10 | | | | | | **10** |
| **SECTION – B** (5-Marks) (Either/or type) (5x4 = 20) | | 04 | 08 | 08 | | | **20** |
| **SECTION – C** (10 Marks) (3 out of 5) (3x10 =30) Courses having only **K5,K6** levels, K5 level - 3 Questions, K6 level- 2 Questions **(One K6 level question is compulsory)** | | | | | 20 | 10 | **30** |
| **Total** | **20** | **04** | **08** | **08** | **20** | **10** | **70** |

## EVALUATION
## GRADING SYSTEM

Once the marks of the CIA and the end-semester examination for each of the courses are available, they will be added and converted as final mark. The marks thus obtained will then be graded as per the scheme provided in Table-1.

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

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

$$\text{WAM(Weighted Average Marks)}=\frac{\sum_{i=1}^{n} C_i M_i}{\sum_{I=1}^{n} C_i}$$

Where,

$C_i$is the Credit earned for the Course

$G_i$ is the Grade Point obtained by the student for the Course $M_i$is the marks obtained for the course and

n is the number of Courses **Passed** in that semester.

**CGPA:** Average GPA of all the Courses starting from the first semester to the current semester.

## CLASSIFICATION OF FINAL RESULTS:

1. The classification of final results shall be based on the CGPA, as indicated in Table-2.
2. For the purpose of Classification of Final Results, the candidates who earn the CGPA 9.00 and above shall be declared to have qualified for the Degree as _Outstanding‘. Similarly the candidates who earn the CGPA between 8.00 and 8.99, 7.00 and 7.99, 6.00 and 6.99 and 5.00 and 5.99 shall be declared to have qualified for their Degree in the respective programmes as _Excellent‘, _Very Good‘, _Good‘, and _Above Average‘ respectively.
3. Absence from an examination shall not be taken an attempt.

**Table- 1: Grading of the Courses**

| Marks Range | Grade Point | Corresponding Grade |
|---|---|---|
| 90 and above | **10** | **O** |
| 80 and above and below 90 | **9** | A+ |
| 70 and above and below 80 | **8** | **A** |
| 60 and above and below 70 | **7** | **B+** |
| 50 and above and below 60 | **6** | **B** |
| Below50 | **NA** | **RA** |

**NA - Not Applicable, RA - Reappearance**

The candidates‘ performance in every current semester is indicated by **Semester Grade Point Average (SGPA)** and from the second semester onwards, the continuous performance including previous semester/s is indicated by **Cumulative Grade Point Average (CGPA)**

**Table-2: Final Result**

| CGPA | Corresponding Grade | Classification of Final Result |
|---|---|---|
| 9.00 and above | **O** | **Outstanding** |
| 8.00 to 8.99 | A+ | **Excellent** |
| 7.00 to 7.99 | **A** | **Very Good** |
| 6.00 to 6.99 | **B+** | **Good** |
| 5.00 to 5.99 | **B** | **Above Average** |

* The candidates who have passed in the first appearance and within the prescribed duration of the PG Programme are eligible. If the candidate‘s Grade is O/A+ with more than one attempt, the performance is fixed as ―Very Good‖

### Vision

To become a centre of excellence in Physics by dissemination and creation of knowledge through teaching and research in Physics at various levels and to help create a scientific society which encourages logical thinking.

### Mission

Providing best infrastructure, opportunities and environment to students through which they obtain excellence in knowledge in Physics. Exposing the students in developing protocols for the working modules in Physics.

## PROGRAMME OUTCOMES: M.Sc., DEGREE PROGRAMMES

| PO No. | Programme Outcomes<br>*(Upon completion of the M.Sc., Degree Programme, the Post graduate will be able to)* |
|---|---|
| **PO-1** | **Disciplinary Knowledge**: demonstrate in-depth knowledge and understanding of theories, policies, and practices in one or more disciplines that form a part of a Post Graduate program of study in Master of Science. |
| **PO-2** | **Critical Thinking and Problem Solving**: apply analytic thought to a body of knowledge, analyse and evaluate evidence, arguments, claims, beliefs on the basis of empirical evidence, identify relevant assumptions or implications, formulate coherent arguments, critically evaluate practices, policies and theories by following scientific approach to knowledge development: solve problems and extrapolate the same to real life situation |
| **PO-3** | **Information/digital literacy and Communication Skills:** use ICT in a varietyof learning situations, demonstrate ability to access, evaluate, and use a variety of relevant information sources, and use appropriate software for analysis of data: communicate thoughts and ideas analytically and effectively in writing and orally using appropriate media, and present complex information in a clear and concise manner to different groups.. |
| **PO-4** | **Research-related skills:** conduct independent inquiry in a chosen scientific discipline, demonstrate sense of inquiry and capability for asking relevant/appropriate questions, problem atising, synthesizing and articulating; recognize cause-and-effect relationships, define problems, formulate hypotheses, test hypotheses, analyse, interpret and draw conclusions from data, establish hypotheses, predict cause-and-effect relationships; plan, execute and report the results of an experiment or investigation. |
| **PO-5** | **Scientific reasoning and Reflective Thinking:** analyse, interpret and draw conclusions from quantitative/qualitative data and critically evaluate ideas, evidence and experiences from an open-minded and reasoned perspective; critically and sensibly evaluate life experiences, with self awareness and reflexivity of both self and society. |
| **PO-6** | **Multidisciplinary Approach, Innovation and Entrepreneurship:** propose novel ideas of interdisciplinary approach in providing better solutions and new ideas for the sustainable developments; identify opportunities, entrepreneurship vision and use of innovative ideas to create value and wealth for the betterment of the individual and society. |

| | |
|---|---|
| **PO-7** | **Moral and ethical awareness/reasoning:** embrace moral/ethical values in conducting one‘s life, formulate a position/argument about an ethical issue from multiple perspectives, and use ethical practices in all work, demonstrate the ability to identify ethical issues related to one‘s work, avoid unethical behavior such as fabrication, falsification or misrepresentation of data or committing plagiarism, not adhering to intellectual property rights, appreciate environmental and sustainability issues, and adopt objective, unbiased and truthful actions in all aspects of work. |
| **PO-8** | **Self directed Learning:** work independently, identify appropriate resources required for a project, and manage a project till completion. |
| **PO-9** | **Lifelong Learning:** engage in continuous learning for professional growth and development, acquire knowledge and skills, adapt to changing environment and to changing trades and demands of work place through knowledge/skill development/ reskilling. |
| **PO-10** | **Multicultural Competence, Social Interaction and Effective Citizenship:** understand the values and beliefs of multiple cultures, global perspectives, engage and interact respectfully with diverse groups and elicit views of others, mediate disagreements and help reach conclusions in group settings, and demonstrate empathetic social concern and equity centred national development |

# PROGRAMME SPECIFIC OUTCOMES - (PSO)

| **PSO No.** | **Program Specific Outcomes (M.Sc., PHYSICS)** |
|---|---|
| **PSO1** | Understand and apply inter disciplinary concepts of Physics for describing the natural phenomenon. |
| **PSO2** | Demonstrate mathematical, statistical, computational and experimental techniques in problem solving. |
| **PSO3** | Implement the analytical methods required to interpret and analyze results and draw conclusions as supported by their data. |
| **PSO4** | Design the programme as a whole opens up several carrier doors for the students interested in various areas of physics in private, public and government sectors. |
| **PSO5** | Pursue research related to Physics and Materials characterization. |
| **PSO6** | Understanding the basic concepts of physics particularly concepts in classical mechanics, quantum mechanics, electrodynamics and electronics to appreciate how diverse phenomena observed in nature follow from a small set of fundamental laws. |
| **PSO7** | Acquire scientific and problem solving skills by performing experiments in general physics and electronics |

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## M.Sc., PHYSICS
## CHOICE BASED CREDIT SYSTEM - LEARNING OUTCOMES BASED CURRICULUM FRAMEWORK (CBCS - LOCF)

**(Applicable to the candidates admitted from the academic year 2026-2027)**

**ELIGIBILITY:** A candidate who is a graduate of this University or any recognized University in B.Sc., Physics / B.Sc. Electronics /Applied Physics / Four years Physics (Honours)

| Sem. | Course | Course Code | Course Title | Ins. Hrs. | Credit | Exam Hrs. | Marks | | Total |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Int. | Ext. | |
| I | Core Course - I (CC - I) | P26PH101 | Mathematical Physics | 6 | 4 | 3 | 30 | 70 | 100 |
| | Core Course - II (CC - II) | P26PH102 | Classical Mechanics and Relativity | 6 | 4 | 3 | 30 | 70 | 100 |
| | Core Practical - I (CP - I) | P26PH103P | General and Electronics Laboratory – I | 6 | 4 | 3 | 40 | 60 | 100 |
| | Discipline Centric Elective Course - I (DCEC- I) | P26PHDE11A | Electronics and Instrumentation | 5 | 4 | 3 | 30 | 70 | 100 |
| | | P26PHDE11B | Communication Electronics | | | | | | |
| | | P26PHDE11C | Electronic Devices and Circuits | | | | | | |
| | Generic Elective Course – I (GEC - I) | P26PHGE11A | Spectroscopy | 5 | 3 | 3 | 30 | 70 | 100 |
| | | P26PHGE11B | Biophysics | | | | | | |
| | | P26PHGE11C | Lasers and Nonlinear Optics | | | | | | |
| | Skill Enhancement Course – I (SEC - I) | P26SEPH11 | Computational Physics with Python | 2 | 2 | 3 | 30 | 70 | 100 |
| | Value Added Course – I (VAC - I)* | P26PHVA11 | Advanced AI Applications in Physics and Computational Sciences | - | 2* | | 30 | 70 | 100* |
| | **Total** | | | **30** | **21** | **-** | **-** | **-** | **600** |
| II | Core Course - III (CC - III) | P26PH204 | Quantum Mechanics | 6 | 4 | 3 | 30 | 70 | 100 |
| | Core Course - IV (CC - IV) | P26PH205 | Thermodynamics and Statistical Mechanics | 6 | 4 | 3 | 30 | 70 | 100 |
| | Core Practical - II (CP - II) | P26PH206P | Computational Physics Laboratory | 6 | 4 | 3 | 40 | 60 | 100 |
| | Discipline Centric Elective Course - II (DCEC - II) | P26PHDE22A | Advanced Optics | 4 | 4 | 3 | 30 | 70 | 100 |
| | | P26PHDE22B | Advanced Spectroscopy | | | | | | |
| | | P26PHDE22C | Advanced Mathematical Physics | | | | | | |
| | Generic Elective Course – II (GEC -II) | P26PHGE22A | Physics of Nanoscience and Technology | 4 | 3 | 3 | 30 | 70 | 100 |
| | | P26PHGE22B | Cosmology | | | | | | |
| | | P26PHGE22C | Recycling of Solid Waste Materials | | | | | | |
| | Skill Enhancement Course – II (SEC - II) | P26SEPH22 | Medical Physics | 2 | 2 | 3 | 30 | 70 | 100 |
| | Non-Major Elective Course – I (NMEC - I) | | | 2 | 2 | 3 | 30 | 70 | 100 |
| | **Total** | | | **30** | **23** | **-** | **-** | **-** | **700** |
| **Summer Internship / Industrial Activity during the Summer Vacation after 1st Year** | | | | | | | | | |

|  |  |  |  |  |  |  |  |  |  |
|---|---|---|---|---|---|---|---|---|---|
| III | Core Course - V (CC - V) |  | Electromagnetic Theory | 6 | 4 | 3 | 30 | 70 | 100 |
|  | Core Course – VI(CC -VI) |  | Crystal Growth and Thin Film Physics | 6 | 4 | 3 | 30 | 70 | 100 |
|  | Core Practical-III (CP - III) |  | General and Electronics Laboratory – II | 6 | 4 | 3 | 40 | 60 | 100 |
|  | Discipline Centric Elective Course - III (DCEC - III) |  | Microprocessor and Microcontroller | 5 | 4 | 3 | 30 | 70 | 100 |
|  |  |  | Optoelectronics |  |  |  |  |  |  |
|  |  |  | Nonlinear Dynamics |  |  |  |  |  |  |
|  | Generic Elective Course – III (GEC - III) |  | Research Methodology | 5 | 3 | 3 | 30 | 70 | 100 |
|  |  |  | Quantum Field Theory |  |  |  |  |  |  |
|  |  |  | Plasma Physics |  |  |  |  |  |  |
|  | Non-Major Elective Course – II (NMEC - II) |  |  | 2 | 2 | 3 | 30 | 70 | 100 |
|  | Internship / Industrial Activity @ |  |  | - | 2 | - | 20 | 80 | 100 |
|  | Value Added Course – II (VAC - II)* |  | Advances in Data Science Using Python and R Programming | - | 2* | - | 30 | 70 | 100* |
|  | **Total** |  |  | **30** | **23** | **-** | **-** | **-** | **700** |
| IV | Core Course – VII (CC - VII) |  | Nuclear and Particle Physics | 6 | 4 | 3 | 30 | 70 | 100 |
|  | Core Course –VIII (CC - VIII) |  | Condensed Matter Physics | 6 | 4 | 3 | 30 | 70 | 100 |
|  | Core Practical – IV (CP - IV) |  | Microprocessor 8085 Programming Laboratory | 6 | 4 | 3 | 30 | 70 | 100 |
|  | Discipline Centric Elective Course - IV (DCEC - IV) |  | Characterization of Materials | 4 | 4 | 3 | 30 | 70 | 100 |
|  |  |  | Advanced Quantum Mechanics |  |  |  |  |  |  |
|  |  |  | Advanced Materials |  |  |  |  |  |  |
|  | Entrepreneurship / Industry Based Course |  | Solar Energy Utilization | 3 | 3 | 3 | 30 | 70 | 100 |
|  | Project Work @ |  |  | 5 | 5 | - | 20 | 80 | 100 |
|  | Extra Credit Course other than VAC** |  | MOOC - NPTEL / SWAYAM** | - | 2** | - | - | - | - |
|  | **Total** |  |  |  | **24** | **-** | **-** | **-** | **600** |
| **Grand Total** |  |  |  |  | **91** |  |  |  | **2600** |

## LIST OF DISCIPLINE CENTRIC ELECTIVE COURSE

| S. No. | Semester | Discipline Centric Elective Course (DCEC) |
|---|---|---|
| | | **Discipline Centric Elective Course - I (DCEC – I )** |
| 1. | I | Electronics and Instrumentation |
| 2. | | Communication Electronics |
| 3. | | Electronic Devices and Circuits |
| | | **Discipline Centric Elective Course - II (DCEC - II)** |
| 1. | II | Advanced Optics |
| 2. | | Advanced Spectroscopy |
| 3. | | Advanced Mathematical Physics |
| | | **Discipline Centric Elective Course - III (DCEC - III)** |
| 1. | III | Microprocessor and Microcontroller |
| 2. | | Optoelectronics |
| 3. | | Nonlinear Dynamics |
| | | **Discipline Centric Elective Course - IV (DCEC - IV)** |
| 1. | IV | Characterization of Materials |
| 2. | | Advanced Quantum Mechanics |
| 3. | | Advanced Materials |

## LIST OF GENERIC ELECTIVE COURSE (GEC)

| S. No. | Semester | Generic Elective Course (GEC) |
|---|---|---|
| | | **Generic Elective Course - I (GEC – I )** |
| 1. | I | Spectroscopy |
| 2. | | Biophysics |
| 3. | | Lasers and Nonlinear Optics |
| | | **Generic Elective Course - II (GEC – II )** |
| 1. | II | Physics of Nanoscience and Technology |
| 2. | | Cosmology |
| 3. | | Recycling of Solid Waste Materials |
| | | **Generic Elective Course - III (GEC – III )** |
| 1. | III | Research Methodology |
| 2. | | Quantum Field Theory |
| 3. | | Plasma Physics |

## NON MAJOR ELECTIVE COURSE (NMEC) OFFERED BY THE DEPARTMENT

| S.No. | Semester | Course Code | Title of the Course |
|---|---|---|---|
| 1 | II | P26NMEPH21 | Physics for Everyone |
| 2 | III | | Digital Communication |

## SUMMARY OF CURRICULUM STRUCTURE OF PG PROGRAMMES: SCIENCE

| Sl. No. | Types of the Course | No. of Courses | Credits for each Course | Total Credits | Marks |
|---|---|---|---|---|---|
| 1. | Core Course (CC) | 8 | 4 | 32 | 800 |
| 2. | Core Practical (CP) | 4 | 4 | 16 | 400 |
| 3. | Discipline Centric Elective Course (DCEC) | 4 | 4 | 16 | 400 |
| 4. | Generic Elective Course (GEC) | 3 | 3 | 9 | 300 |
| 5. | Skill Enhancement Course (SEC) | 2 | 2 | 4 | 200 |
| 6. | Non-Major Elective Courses (NMEC) | 2 | 2 | 4 | 200 |
| 7. | Internship / Industrial Activity @ | 1 | 2 | 2 | 100 |
| 8. | Entrepreneurship/<br>Industry Based Course | 1 | 3 | 3 | 100 |
| 9. | Project Work @ | 1 | 5 | 5 | 100 |
| **Total** | | **26** | **-** | **91** | **2600** |
| Value Added Courses * | | 2* | 2 | 4* | 200 |
| MOOC - NPTEL / SWAYAM** | | 2** | 2 | 2** | |

* **The value added courses credit will not included in the total CGPA. These courses are extra-credit courses. Instruction hours for these courses is 30 hours**

@ Summer Internship will be carried out during the summer vacation after the First year. Viva Voce will be conducted by the college and Marks shall be sent to the University and the same will be included in the 3rd semester Mark Statement.

**Summer Internship / Industrial Activity& Project:**
**Scheme of Evaluation:**

| **Description** | **Marks** |
|---|---|
| Report | 80 |
| Viva | 20 |
| Total | 100 |

# SEMESTER I

## SENGAMALA THAYAAR EDUCATIONAL TRUST WOMEN'S COLLEGE
## (AUTONOMOUS)
## SUNDARAKKOTTAI, MANNARGUDI – 614 016
*(For the Candidate admitted in the academic year 2026-2027)*
## DEPARTMENT OF PHYSICS
## M. Sc., PHYSICS

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### Semester: I – CC - I: MATHEMATICAL PHYSICS

**Ins. Hrs. /Week: 6** **Course Credit: 4** **Course Code: P26PH101**

### COURSE OBJECTIVES
- To develop knowledge of vector calculus and its applications in Physical sciences.
- To understand matrices, eigenvalues and eigenvectors for solving Physical and Mathematical problems.
- To apply complex variable techniques and contour integration in Physics applications.
- To solve ordinary differential equations using analytical and power series methods.
- To understand Sturm – Liouville problems and special functions used in Mathematical Physics.

### UNIT I: VECTOR CALCULUS (18 Hours)
Vector integration – Line integral – Path independence – Surface integral – Flux – Volume integral – Green‘s theorem – Stokes‘ theorem – Divergence theorem – Orthogonal curvilinear coordinates – Unit vectors in curvilinear coordinate system – Gradient, divergence, curl and Laplacian in cylindrical and spherical polar coordinates.

### UNIT II: MATRICES (18 Hours)
Matrix algebra – Solution of a system of linear equations – Properties of (i) symmetric, (ii) anti-symmetric, (iii) orthogonal, (iv) Hermitian, (v) skew-Hermitian and (vi) unitary matrix – Eigenvalues and eigenvectors of a square matrix – Diagonalization – Matrix Analysis of Single nth order differential equation and system of second order linear differential equations and their solutions.

### UNIT III: COMPLEX ANALYSIS (18 Hours)
Review of Complex Numbers -de Moivre‘s theorem-Functions of a Complex Variable-Differentiability -Analytic functions- Harmonic Functions- Complex Integration- Contour Integration, Cauchy – Riemann conditions – Singular points – Cauchy‘s Integral Theorem and integral Formula -Taylor‘s Series - Laurent‘s Expansion-Zeros and poles – Residue theorem and its Application: Potential theory - (1) Electrostatic fields and complex potentials - Parallel plates, coaxial cylinders and an annular region (2) Heat problems - Parallel plates and coaxial cylinders.

### UNIT IV: ORDINARY DIFFERENTIAL EQUATIONS (18 Hours)
Methods of finding solutions of first and second order ordinary differential equations (ODEs) with constant coefficients – Initial value and boundary value problem – Methods of finding solutions – Superposition principle – Wronskian – Definition of ordinary and singular points of second order ODEs – Power series solution – Examples – Solutions about ordinary point and singular point in power series.

### UNIT V: SPECIAL FUNCTIONS (18 Hours)
Strum-Liouville problem – Basic properties – Need for studying Strum-Liouville problems in physics – Specific examples for Strum-Liouville equation: (i) Legendre, (ii) Hermite and (iii) Laguerre differential equations – Power series solutions – Polynomials – Generating function – Rodrigue‘s formula – Recursion relations – Orthogonality relations.

### UNIT VI: CURRENT CONTOURS (For Continuous Internal Assessment only – Self Study)
Beta, Gamma and Delta functions – Concepts of regression, dimensionality reduction, density estimation and classification – Linear filters and wavelets.

**Total Lecture Hours - 90**

## COURSE OUTCOMES

On the successful completion of the course, students will be able to

1. Acquire the essential mathematical skills to solve problems in various branches of Physics.
2. Understand the usefulness of vector integration theorems and their utility in solving Physics problems arising in electromagnetic theory and other branches of physics.
3. Know the usefulness of matrices and matrix operations in solving physics and engineering problems.
4. Attain sound knowledge of classical orthogonal polynomials and their applications in Quantum Physics.
5. Solve various kinds of differential equations that model a variety of natural systems.
6. Understand advanced mathematical concepts such as Beta, Gamma and Delta functions, regression, dimensionality reduction and wavelets.

## TEXT BOOK (S)

1. H K. Dass and R. Verma, Mathematical Physics (S. Chand, New Delhi, 2022).
2. A Textbook of Mathematical Physics – I – S. Chand Publishing, 2026 Edition.
3. Mathematical Physics - S. Chand Publishing, Revised Edition, 2024.
4. B. D. Gupta, Mathematical Physics (S. Chand, New Delhi, 2009).
5. Sathya Prakash, Mathematical Physics with Classical Mechanics (S. Chand, New Delhi, 2021).

## REFERENCE BOOK(S)

1. E. Kreysig, H. Kreysig and E. J. Norminton, Advanced Engineering Mathematics (John Wiley, New Delhi, 2011).
2. T. L. Chow, Mathematical Methods for Physicists: A Concise Introduction (Cambridge University Press, Cambridge, 2014).
3. P. Boas, Mathematical Methods in the Physical Sciences (Wiley, New York, 2018).
4. Physics for B.Sc. Students: Mathematical Physics I – S. Chand Publishing, 2026 Edition.
5. M. P. Deisenroth, A. A. Faisal and C. S. Ong, Mathematics for Machine Learning (Cambridge University Press, Cambridge, 2020).

## E- RESOURCES

1. https://nptel.ac.in/courses/115103036
2. http://www.issp.ac.ru/ebooks/books/open/Mathematical%20Methods.pdf
3. http://hyperphysics.phy-astr.gsu.edu/hbase/hmat.html#hmath
4. www.mit.edu
5. www.nptel.ac.in

## MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | 3 | 2 | 2 | 2 | 1 | 2 | 2 | 3 | 2 | 2 | 3 | 2 | 2 | 2 |
| **CO2** | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 2 | 3 | 2 | 2 | 2 |
| **CO3** | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 2 | 2 | 2 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 2 |
| **CO5** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| **CO6** | 2 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 2 | 3 | 3 | 3 |

**S-Strong (3)    M-Medium (2)    L-Low (1)**

**SENGAMALA THAYAAR EDUCATIONAL TRUST WOMEN’S COLLEGE**
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**DEPARTMENT OF PHYSICS**
**M. Sc., PHYSICS**

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## Semester: I – CC - II: CLASSICAL MECHANICS AND RELATIVITY

**Ins. Hrs. /Week: 6** **Course Credit: 4** **Course Code: P26PH102**

### COURSE OBJECTIVES

- To provide in-depth knowledge on the foundations of Classical Mechanics.
- To familiarize the laws of motion and learn about their applications in other Branches of Physics.
- To build a strong base on dynamical system.
- To apply the theory of small oscillations and vibrations to coupled systems.
- To understand the fundamentals of special relativity and relativistic Mechanics.

### UNIT I: LAGRANGE’S FORMULATION (18 Hours)

Mechanics of a system of particles – Constraints – Generalized coordinates – D Alembert‘s principle and Lagrange‘s equations – Simple application of the Lagrangian formulation – Hamilton‘s (Variational) principle and derivation of Lagrange‘s equations – Generalized momenta and energy – Cyclic coordinates – Conservation Laws.

### UNIT II: CENTRAL FORCE MOTION AND RIGID BODY DYNAMICS (18 Hours)

Central Force Motion: General Features – The Kepler Problem: inverse square law force – Scattering in a central force field. Rigid Body Dynamics: Moment of inertia tensor – Euler angles – Euler‘s equations of motion – Symmetrical top – Problems.

### UNIT III: HAMILTON’S FORMULATION (18 Hours)

Legendre transformation – Hamiltonian and Hamilton‘s equation of motion – Properties – Derivation of Hamilton‘s equations from variational principle – Canonical transformation – Applications – Poisson brackets – Hamilton Jacobi equation for Hamilton‘s principle function – Hamilton‘s characteristic function – Application (Harmonic Oscillator) – Action-angle variables - Problems.

### UNIT IV: SMALL OSCILLATIONS AND VIBRATIONS: SMALL OSCILLATIONS (18 Hours)

Theory of small oscillations – Eigenvalue problem – Normal modes and Normal frequencies - Frequencies of free vibrations – Normal coordinates – Examples – Two coupled Pendula - Linear triatomic molecule – Forced vibrations.

### UNIT V: THEORY OF RELATIVITY (18 Hours)

Inertial and non-inertial reference frames – Addition of velocities, mass, energy – Mass-Energy equivalence – Pseudo forces – Galilean and Lorentz transformations – Invariance of Maxwell‘s equations under Lorentz transformation – Lagrangian and Hamiltonian of relativistic particles.

### UNIT VI: CURRENT CONTOURS (For Continuous Internal Assessment only – Self Study)

Nonlinear Dynamical Systems - Linear Stability Analysis – Classification of Fixed Points. Hamilton‘s Principle and Lagrange‘s equations to electrical systems – Dynamics of Gyroscopes – Multibody Dynamics and Robotics.

**Total Lecture Hours - 90**

## COURSE OUTCOMES

On the successful completion of the course, students will be able to

1. Solve problems involving Lagrangian and Hamiltonian Mechanics.
2. Attain sound knowledge of the basic formalism and geometric aspects of Classical Mechanics.
3. Understand the usefulness of variational calculus in formulating the Mechanical laws of motion.
4. Find solutions to problems in the normal mode analysis and its applications.
5. Get familiarized with the dynamical systems.
6. Explain relativistic mechanics and apply Lorentz transformations in Physical systems.

## TEXT BOOK(S)

1. H. Goldstein, C. P. Poole and J. Safko, Classical Mechanics (Pearson, New Delhi, 2011).
2. G. Aruldhas, Classical Mechanics (Prentice Hall of India, New Delhi, 2015).
3. B. D. Gupta and Satya Prakash, Classical Mechanics (Kedar Nath Ram Nath, Meerut, 2020).
4. Classical Mechanics, Pearson Education, 3rd Edition, 2026 Reprint.
5. Introduction to Classical Mechanics, Tata McGraw Hill, 2026 Edition.

## REFERENCE BOOK(S)

1. N. Rana and P. Joag, Classical Mechanics (McGraw Hill, New Delhi, 2017).
2. H. V. Sharma, S. L. Gupta and V. Kumar, Classical Mechanics (Pragati Prakashan, New Delhi, 2019).
3. R. G. Takwale and P. S. Puranik, Introduction to Classical Mechanics (McGraw Hill, New Delhi, 2017).
4. Mathematical Methods of Classical Mechanics, Springer, 2026 Edition.
5. Classical Dynamics of Particles and Systems, Cengage Learning, 2026 Edition.

## E - RESOURCES

1. https://ocw.mit.edu/courses/8-09-classical-mechanics-iii-fall2014/pages/lecture-notes/
2. http://poincare.matf.bg.ac.rs/~zarkom/Book_Mechanics_Goldstein_Classical_Mechanics_optimized.pdf
3. https://pdfcoffee.com/classical-mechanics-j-c-upadhyay-2014-editionpdf-pdf-free.html
4. www.cambridge.org
5. www.britannica.com

## MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | 3 | 2 | 2 | 2 | 1 | 2 | 2 | 3 | 3 | 2 | 3 | 2 | 2 | 2 |
| **CO2** | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 2 | 2 | 2 |
| **CO3** | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 2 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| **CO5** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO6** | 2 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 2 | 3 | 3 | 3 |

**S-Strong (3) M-Medium (2) L-Low (1)**

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## Semester: I – CP - I: GENERAL AND ELECTRONICS LABORATORY - I

**Ins. Hrs. /Week: 6** **Course Credit: 4** **Course Code: P26PH103P**

### COURSE OBJECTIVES

- To provide practical knowledge of advanced experimental techniques in Physics.
- To develop skills in handling scientific instruments and measurement systems.
- To understand the Principles of Optics, Electronics, Magnetism and Modern Physics through experiments.
- To train students in data analysis, calculations and error estimation methods.
- To enhance scientific observation, reporting and problem-solving abilities in laboratory work.

### A. GENERAL PHYSICS EXPERIMENTS:

1. Determination of q, n, σ by elliptical fringes method.
2. Determination of Stefan's constant.
3. Determination of bulk modulus of a liquid by ultrasonic wave propagation.
4. Determination of Rydberg's constant.
5. Study of Hall effect in a semiconductor.
6. Determination of dielectric constant at high frequency by Lecher wire.
7. Michelson interferometer - Determination of wavelength of monochromatic source.
8. Determination of wavelength of monochromatic source using Biprism.
9. Charge of an electron by spectrometer.
10. Polarization of light - Verification of Malus law and Brewster angle of glass.
11. BH loop – Energy loss of a magnetic material – Anchor ring using B.G./CRO.
12. Determination of e/m of an electron by magnetron method.

### B. ELECTRONICS EXPERIMENTS:

1. Construction of dual regulated power supply.
2. Astable and Monostable Multivibrators using IC555.
3. Characteristics of UJT.
4. Characteristics of SCR.
5. Design and study of Wein bridge oscillator using op-amp.
6. Design and study of square and triangular waves generators using op-amp.
7. V-I characteristics of a solar cell.
8. Operation of shift register using serial-in serial-out, serial-in parallel-out and parallel-in serial-out.
9. Digital to analog converter - R-2R and weighted method.
10. BCD to 7 segment display.
11. Study of A/D converter - Counter ramp type method.

**Total Lecture Hours – 90**

## COURSE OUTCOMES

On the successful completion of the course, students will be able to

1. Perform advanced Physics experiments using optical, electrical and semiconductor instruments.
2. Analyze experimental data and determine physical constants with accuracy.
3. Apply theoretical concepts of optics, electronics, magnetism and modern Physics in laboratory measurements.
4. Apply experimental methods and laboratory techniques to determine important physical constants and analyze physical phenomena accurately.
5. Develop skills in handling scientific instruments, error analysis and interpretation of results.
6. Demonstrate scientific reporting, observation and problem – solving skills in experimental Physics.

## TEXT BOOK(S)

1. G. Kennedy, Electronic Communication Systems (McGraw Hill, New Delhi, 1994).
2. Gupta and Kumar, Practical Physics, Pragati Prakasan Kit Developed for doing experiments in Physics -Instruction manual.
3. D. R. Choudhury and S. Jain, Linear Integrated circuits (New Age International, New Delhi, 2001)
4. B.Sc. Practical Physics, S. Chand Publishing, 2026 Edition.
5. Advanced Practical Physics for Students, Asia Publishing House, 2026 Edition.

## REFERENCE BOOK(S)

1. K. A. Navas, Electronics Lab Manual, Volume I&II (Rajat Publications, New Delhi, 2015).
2. M. N. Avadhanulu, A. A. Dani and P. M. Pokley, Experiments in Engineering Physics (S. Chand, New Delhi,1999).
3. Fundamentals of Physics Laboratory Experiments, Cengage Learning, 2026 Edition.
4. Experiments in Modern Physics, Academic Press, 2026 Edition.
5. Practical Physics, Pragati Prakashan, 2026 Edition.

## E - RESOURCES

1. https://lo-au.vlabs.ac.in/exp/newton-rings/theory.html?utm_source=chatgpt.com
2. https://vlab.amrita.edu/?sub=1&brch=282&sim=879&cnt=1&utm_source=chatgpt.com
3. https://vlab.amrita.edu/?sub=1&brch=282&sim=1506&cnt=1&utm_source=chatgpt.com
4. www.physicslab.org
5. www.nptel.ac.in

## MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 1 | 2 | 3 | 2 | 2 | 2 | 3 | 2 | 2 | 2 |
| CO2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | 3 |
| CO3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| CO4 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 |
| CO5 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO6 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |

**S-Strong (3) M-Medium (2) L-Low (1)**

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## Semester: I – DCEC - I: ELECTRONICS AND INSTRUMENTATION

**Ins. Hrs. /Week: 5** **Course Credit: 4** **Course Code: P26PHDE11A**

### COURSE OBJECTIVES

- Recap the basics of semiconductors, doping, types of semiconductors and carrier transport.
- Understand semiconductor junctions, heterojunctions, field-effect transistors and optoelectronic devices, including LEDs, laser diodes, and photovoltaic devices.
- Explore operational amplifiers, feedback principles, oscillators, voltage regulators and advanced circuits like PLLs, log, and antilog amplifiers.
- Study instrumentation systems, bridge circuits, transducers, signal conditioning, data acquisition and digital signal processing techniques for practical applications.
- Examine logic circuits, memory, microprocessors, microcontrollers, A/D and D/A conversions and digital modulation in communication systems.

### UNIT I: SEMICONDUCTOR PHYSICS (15 Hours)

Energy bands – Intrinsic & Extrinsic Carrier Concentration - doping-Donors and acceptors – Carrier Transport - Drift-Diffusion-Generation and Recombination process – metal semiconductor junction – Schottky barrier – Ohmic contacts – Ideal Diode Characteristics.

### UNIT II: SEMICONDUCTOR DEVICES (15 Hours)

p-n Junction – Heterojunction - Field Effect Transistors: Characteristics of FET and MOSFET, operation - Optoelectronics devices: Light emitting diode (LED)- Laser diode – Photodiode and Photovoltaic device.

### UNIT III: ANALOG ELECTRONICS (15 Hours)

Operational Amplifiers: Introduction - Differential Amplifiers – Op-Amp Parameters – Negative feedback - comparators - mathematical operations – Active Filters. Oscillators: Feedback Oscillator principles – Oscillators with RC and LC feedback circuits – Relaxation Oscillators – 555 timers as an Oscillator and Schmitt trigger - Log and antilog amplifier - Phase-locked Loop (PLL). Voltage regulators: principle and operations.

### UNIT IV: ELECTRONIC INSTRUMENTATION (15 Hours)

Basics of instrumentation system – bridge circuits: Wheatstone, AC, Wien, capacitance and inductance comparison. Transducers: resistive, strain gauge, resistive thermometer, thermistor, LVDT, load cell, piezoelectric transducers. Signal conditioning – instrumentation amplifier-analog switches - sample & hold circuits - data acquisition and conversion- Voltage-to-frequency and frequency – to – voltage converters - data transmission – digital signal processing.

### UNIT V: DIGITAL ELECTRONICS AND COMMUNICATION (15 Hours)

Introduction – overview of logic functions and logic gates – combinational logic – flip-flops and related circuits – sequential logic – registers, counters, shift-registers and memory – microprocessor architecture (8085, 8086, 8088) – microcontroller (8051) – A/D and D/A conversion – DSP fundamentals. Digital modulation and communication schemes.

**Total Lecture Hours – 75**

## UNIT VI: CURRENT CONTOURS (For Continuous Internal Assessment only – Self Study)

Fundamentals of Electronic Components and Circuits - Measurement Systems - Sensors and Transducers and Signal Conditioning Techniques.

## COURSE OUTCOMES

1. Demonstrated knowledge of semiconductor junctions, heterojunctions, field-effect transistors and optoelectronic devices such as LEDs, laser diodes, and photovoltaic devices (K1, K2, K3).
2. Gained an understanding of operational amplifiers, feedback principles, oscillators, voltage regulators and advanced circuits like PLLs, log, and antilog amplifiers (K2, K3).
3. Acquired expertise in instrumentation systems, bridge circuits, transducers, signal conditioning, data acquisition and digital signal processing techniques (K2, K3, K4).
4. Explored logic circuits, memory, microprocessors, microcontrollers, A/D and D/A conversions and digital modulation techniques used in communication systems (K2, K3, K4).
5. Analyzed nonlinear circuits, piecewise linear elements, memristive devices, oscillators and chaotic systems like Chua's oscillator and Wien-bridge oscillators (K4, K5, K6).
6. Demonstrate knowledge of digital electronics, microprocessors, microcontrollers, A/D–D/A conversion and digital communication systems.

## TEXT BOOK(S)

1. S.M. Sze and M.K. Lee, Semiconductor Devices, John Wiley & Sons, Inc. 3rd Edition, 2012.
2. Umesh K. Mishra and Jasprit Singh, Semiconductor Device Physics and Design, Springer, Netherlands, 2008.
3. Thomas L. Floyd and David M. Buchla, Analog Fundamentals:A systems approach, Pearson, Boston, 2013.
4. Electronic Instrumentation, H. S. Kalsi, *Electronic Instrumentation*, 4th Edition, 2026, McGraw Hill.
5. Digital Electronics: Principles, Devices and Applications,Anil K. Maini, Digital Electronics: Principles Devices and Applications, 2026 Edition, Wiley.

## REFERENCE BOOK(S)

1. Thomas F. Schubert,Jr. and Ernest M. Kim, Fundamentals of Electronics: Book 1,2,3,4, Morgan & Claypool Publishers, 2016.
2. M. Morris Mano and Michael Ciletti, Digital Design, Pearson, Harlow, 2019.
3. Albert Paul Malvino, David J. Bates, Patrick E. Hoppe, Electronic Principles, McGraw-Hill, New Delhi, 2020.
4. Electronic Principles ,Albert Paul Malvino, David J. Bates & Patrick E. Hoppe, *Electronic Principles*, 2026 Edition, McGraw Hill.
5. Electronic Devices and Circuit Theory Robert L. Boylestad & Louis Nashelsky, *Electronic Devices and Circuit Theory*, 12th Edition, 2026, Pearson.

## E - RESOURCES

1. https://nptel.ac.in/courses/108105153
2. https://www.coursera.org/courses?query=electronics
3. https://www.edx.org/learn/electronics
4. www. coursera org
5. www.edx.org.com

## MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | 2 | 3 | 2 | 2 | 1 | 2 | 2 | 3 | 3 | 2 | 2 | 3 | 2 | 2 |
| **CO2** | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 2 |
| **CO3** | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO6** | 2 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 2 | 3 | 3 | 3 |

**S-Strong (3) M-Medium (2) L-Low (1)**

## Semester: I – DCEC - I: COMMUNICATION ELECTRONICS

**Ins. Hrs. /Week: 5** **Course Credit: 4** **Course Code: P26PHDE11B**

## COURSE OBJECTIVES

- To understand the principles of antennas and electromagnetic wave propagation.
- To study the construction and operation of microwave generation devices and waveguides.
- To learn the fundamentals of radar systems and television communication techniques.
- To understand optical fibre communication systems and their applications.
- To gain knowledge of satellite communication systems, orbital mechanics and link budget analysis.

### UNIT I: ANTENNAS AND WAVE PROPAGATION (15 Hours)

Radiation field and radiation resistance of short dipole antenna-grounded antenna-ungrounded antenna-antenna arrays-broadside and end side arrays-antenna gain-directional high frequency antennas-sky wave-ionosphere- Ecles and Larmor theory- Magnento ionic theory-ground wave propagation.

### UNIT II: MICROWAVES (15 Hours)

Microwave generation - multi cavity Klystron-reflex klystron-magnetron travelling wave tubes (TWT) and other microwave tubes-MASER-Gunn diode-wave guides-rectangular wave guides-standing wave indicator and standing wave ratio(SWR).

### UNIT III: RADAR AND TELEVISION (15 Hours)

Elements of a radar system-radar equation-radar performance Factors radar transmitting systems-radar antennas-duplexers-radar receivers and indicators-pulsed systems-other radar systems- colour TV transmission and reception-colour mixing principle-colour picture tubes-Delta gun picture tube-PIL colour picture tube-cable TV, CCTV and theatre TV.

### UNIT IV: OPTICAL FIBER (15 Hours)

Propagation of light in an optical fibre-acceptance angle-numerical aperture-step and graded index fibres-optical fibres as a cylindrical wave guide-wave guide equations-wave guide equations in step index fibres -fibre losses and dispersion-applications

### UNIT V: SATELLITE COMMUNICATION (15 Hours)

Orbital Satellites - Geostationary Satellites - Orbital patterns - Satellite system link models -Satellite system parameters - Satellite system link equation link budget-INSAT communication satellites.

### UNIT VI: CURRENT CONTOURS (For Continuous Internal Assessment only – Self Study)

Fundamentals of Analog and Digital communication systems, Such as Modulation and Demodulation techniques (AM, FM, and basic digital modulation) - Transmitters and Receivers.

**Total Lecture Hours -75**

## COURSE OUTCOMES

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

1. Discuss and compare the propagation of electromagnetic waves through sky and earth‘s surface. Evaluate the energy and power radiated by the different types of antenna.
2. Compare and differentiate the methods of generation of microwaves and analyze the propagation of microwaves through wave guides.
3. Classify and compare the working of different radar systems and compare the working of different picture tubes.
4. Classify, discuss and compare the different types of optical fiber and also to justify the need of it-discover the use of optical fiber as wave guide.
5. Explain the importance of satellite communication in our daily life-distinguish between orbital and geostationary satellites.
6 .Illustrate light propagation in optical fibres and evaluate fibre losses and applications.

## TEXT BOOK(S)

1. Handbook of Electronics by Gupta and Kumar, 2008 edition.
2. Electronic communication systems – George Kennedy and Davis, Tata McGraw Hill, 4th edition, 1988.
3. Microwave Devices and Circuits, Pearson Education, 2026 Edition.
4. Electronic Communication Systems, McGraw Hill Education, 6th Edition, 2026.
5. Optical Fiber Communications, McGraw Hill, 6th Edition, 2026.

## REFERENCE BOOK(S)

1. Electronic communications – Dennis Roody and Coolen, Prentice Hall of India, IV edition, 1995.
2. Wayne Tomasi, Advanced electronics communication systems, fourth edition, Prentice Hall of India, 1998.
3. Dennis Roddy and Coolen, 1995, *Electronics communications,* Prentice Hall of India IV Edition.
4. Modern Digital and Analog Communication Systems, Oxford University Press, 5th Edition, 2026.
5. Radar Engineering, McGraw Hill, 5th Edition, 2026.

## E - RESOURCES

1. https://www.geeksforgeeks.org/digital-electronics-logic-design-tutorials/
2. https://www.polytechnichub.com/difference-analog-instruments-digital-instruments/
3. http://nptel.iitm.ac.in/
4. www. ocw.mit.edu.com
5. www.thefoa.org.com

## MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | 1 | 2 | 2 | 3 | 2 | 1 | 3 | 3 | 3 | 3 | 1 | 2 | 2 | 3 |
| CO2 | 3 | 3 | 3 | 1 | 2 | 2 | 3 | 2 | 1 | 3 | 3 | 3 | 3 | 1 | 2 | 2 | 3 |
| CO3 | 3 | 3 | 3 | 1 | 2 | 2 | 3 | 2 | 1 | 3 | 3 | 3 | 3 | 1 | 2 | 2 | 3 |
| CO4 | 3 | 3 | 3 | 1 | 2 | 2 | 3 | 2 | 1 | 3 | 3 | 3 | 3 | 1 | 2 | 2 | 3 |
| CO5 | 3 | 3 | 3 | 1 | 2 | 2 | 3 | 2 | 1 | 3 | 3 | 3 | 3 | 1 | 2 | 2 | 3 |
| CO6 | 3 | 3 | 3 | 1 | 2 | 2 | 3 | 2 | 1 | 3 | 3 | 3 | 3 | 1 | 2 | 2 | 3 |

**S-Strong (3) M-Medium (2) L-Low (1)**

## SENGAMALA THAYAAR EDUCATIONAL TRUST WOMEN'S COLLEGE
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*(For the Candidate admitted in the academic year 2026-2027)*

## DEPARTMENT OF PHYSICS
## M. Sc., PHYSICS

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### Semester: I – DCEC - I: ELECTRONIC DEVICES AND CIRCUITS

**Ins. Hrs. /Week: 5** **Course Credit: 4** **Course Code: P26PHDE11C**

### COURSE OBJECTIVES

- Develop a solid conceptual foundation in the physics and operation of semiconductor devices.
- Analyze, design, and troubleshoot analog and digital electronic circuits.
- Apply device models to understand current–voltage characteristics in real-world applications.
- Use simulation/analysis tools to evaluate circuit performance for practical environments.
- Integrate the knowledge of electronic devices into advanced technologies used in research and industry.

### UNIT I: SEMICONDUCTOR DIODES (15 Hours)

p-n Junction Diode: Theory of p-n junction diode - Energy band diagram of p-n diode - VI characteristics - Static and dynamic resistances - Diode equivalent circuits - Diode current equation - Diode logic circuits and diode clipper circuits. Zener Diode: VI characteristics - Breakdown mechanism - Zener diode as a voltage regulator. Backward diode: VI characteristics.

### UNIT II: SPECIAL PURPOSE DEVICES (15 Hours)

Tunnel Diode - Photo Diode - Varactor Diode - Schottky Diode – Operation - VI characteristics applications - Principle of operation and Characteristics of SCR. SCR specification - SCR control circuits -The TRIAC and DIAC.

### UNIT III: TRANSISTOR (15 Hours)

Characteristics - Current components Current gain: α and β - Variation of transistor parameter with temperature and current level - Operating point - Hybrid model - h-parameter equivalent circuits. DC and AC analysis of single stage CE - Emitter follower and CB amplifiers - AC and DC load line - Biasing and stabilization techniques - Thermal runaway - Thermal stability.

### UNIT IV: FIELD EFFECT TRANSISTOR & UJT (15 Hours)

JFET& MOSFET**-** Construction and operation - Noise performance of FET - Biasing of JFET‘s and MOSFET‘s - Low Frequency single stage JFET amplifiers - FET as voltage variable resistor and active load - UJT- characteristics - parameters and specification - UJT as relaxation Oscillator.

### UNIT V: SMALL SIGNAL AMPLIFIERS AT LOW FREQUENCY (15 Hours)

Analysis of BJT and FET multistage amplifier - DC and RC coupled amplifiers - Frequency response of single stage - multistage amplifiers - Analysis of differential amplifiers - Miller‘s theorem - Use of Miller and bootstrap configuration - Cascade configuration of multistage amplifiers - Darlington pair.

### UNIT VI: CURRENT CONTOURS (For Continuous Internal Assessment only – Self Study)

Characteristics-comparison of knee voltage and forward bias resistance for different PN diodes - Comparison of transistor parameters for different NPN 33 transistors - Construction of RC Coupled Amplifier with different coupling capacitors and Bypass Capacitors. Nonlinear Electronics – Importance of Nonlinearity in electronics – Periodic and Chaotic Oscillations – Nonlinearity in Power Electronic Circuits.

**Total Lecture Hours -75**

## COURSE OUTCOMES

On the successful completion of the course, students will be able to

1. Understand semiconductor physics and device characteristics.
2. Analyze diode and transistor circuits using appropriate models.
3. Design and evaluate amplifiers, feedback systems, and oscillators.
4. Apply operational amplifiers in various analog applications.
5. Interpret digital circuits, logic families, and data converters.
6. Discuss digital electronics, microprocessors, microcontrollers, communication systems and nonlinear electronic circuits.

## TEXT BOOK(S)

1. S. Salivahanan, N. S. Kumar and A. Vallavaraj, Electronic Devices and Circuits (McGraw Hill, New Delhi, 2016).
2. J. Millman, C. Halkias and C. D. Parikh, Integrated Electronics: Analog and Digital Circuits and Systems (McGraw Hill, New Delhi, 2017).
3. S. L. Gupta and V. Kumar, Hand Book of Electronics (Pragati Prakashan, Meerut, 2013).
4. Integrated Electronics, McGraw Hill Education, 2026 Edition.
5. Electronic Devices and Circuit Theory, Pearson Education, 12th Edition, 2026.

## REFERENCE BOOK(S)

1. B. P. Singh and R. Singh, Electronic Devices and Circuits (Pearson, New York, 2012).
2. K. L. Kishore, Electronic Devices and Circuits (BS Publisher, Hyderabad, 2016).
3. T. L. Floyd, Electronic Devices (Pearson, New Delhi, 2021).
4. Semiconductor Physics and Devices, McGraw Hill, 5th Edition, 2026.
5. Linear Integrated Circuits, New Age International, 2026 Edition.

## E-RESOURCES

1. https://nptel.ac.in/courses/108108112
2. https://archive.org/download/ElectronicDevicesAndCircuitTheory/Electronic%20Devices%20and%20Circuit%20Theory.pdf
3. https://nptel.ac.in/course.html/digital circuits/
4. www.electronics.com
5. www.ieee.org.com

## MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | 2 | 3 | 2 | 1 | 1 | 1 | 2 | 3 | 3 | 2 | 2 | 3 | 2 | 2 |
| CO2 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 2 |
| CO3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| CO5 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| CO6 | 2 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 2 | 3 | 3 | 3 |

**S-Strong (3) M-Medium (2) L-Low (1)**

# SENGAMALA THAYAAR EDUCATIONAL TRUST WOMEN'S COLLEGE
# (AUTONOMOUS)
# SUNDARAKKOTTAI, MANNARGUDI – 614 016

*(For the Candidate admitted in the academic year 2026-2027)*

## DEPARTMENT OF PHYSICS
## M. Sc., PHYSICS

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## Semester: I – GEC - I: SPECTROSCOPY

**Ins. Hrs. /Week: 5** **Course Credit: 3** **Course Code: P26PHGE11A**

### COURSE OBJECTIVES

- To understand the fundamental principles of rotational, vibrational, Raman, resonance and UV Spectroscopy.
- To study the interaction of electromagnetic radiation with atoms and molecules.
- To explain the instrumentation and working principles of modern spectroscopic techniques.
- To analyze molecular structure and bonding using different spectroscopic methods.
- To familiarize students with industrial, medical and research applications of spectroscopy.

### UNIT I: MICROWAVE SPECTROSCOPY (15 Hours)

Rotational spectra of diatomic molecules - Rigid Rotor (Diatomic Molecules)-reduced mass – rotational constant - Effect of isotopic substitution - Non rigid rotator – centrifugal distortion constant- Intensity of Spectral Lines- Polyatomic molecules – linear – symmetric asymmetric top molecules - Hyperfine structure and quadrupole moment of linear molecules - Instrumentation techniques – block diagram -Information Derived from Rotational Spectra- Stark effect- Problems.

### UNIT II: INFRA-RED SPECTROSCOPY (15 Hours)

Vibrations of simple harmonic oscillator – zero-point energy- Anharmonic oscillator – fundamentals, overtones and combinations- Diatomic Vibrating Rotator- PR branch – PQR branch-Fundamental modes of vibration of H2O and CO2 -Introduction to application of vibrational spectra- IR Spectrophotometer Instrumentation (Double Beam Spectrometer) – Fourier Transform Infrared Spectroscopy - Interpretation of vibrational spectra– remote analysis of atmospheric gases like N2O using FTIR by National Remote Sensing Centre (NRSC), India– other simple applications

### UNIT III: RAMAN SPECTROSCOPY (15 Hours)

Theory of Raman Scattering - Classical theory – Molecular Polarizability – Polarizability ellipsoid - Quantum theory of Raman effect - rotational Raman spectra of linear molecule - symmetric top molecule – Stokes and anti-stokes line- SR branch -Raman activity of H2O and CO2 -Mutual exclusion principle- determination of N2O structure -Instrumentation technique and block diagram -structure determination of planar and non-planar molecules using IR and Raman techniques - FT Raman spectroscopy- SERS.

### UNIT IV: RESONANCE SPECTROSCOPY (15 Hours)

Nuclear and Electron spin-Interaction with magnetic field - Population of Energy levels - Larmor precession- Relaxation times - Double resonance- Chemical shift and its measurement - NMR of Hydrogen nuclei - Indirect Spin -Spin Interaction – interpretation of simple organic molecules - Instrumentation techniques of NMR spectroscopy – NMR in Chemical industries- MRI Scan Electron Spin Resonance: Basic principle –Total Hamiltonian (Direct Dipole-Dipole interaction and Fermi Contact Interaction) – Hyperfine Structure (Hydrogen atom ) – ESR Spectra of Free radicals –g-factors – Instrumentation - Medical applications of ESR.

### UNIT V: UV SPECTROSCOPY (15 Hours)

Origin of UV spectra - Laws of absorption – Lambert Bouguer law – Lambert Beer law - molar absorptivity – transmittance and absorbance - Color in organic compounds- Absorption by organic Molecule -Chromophores - Effect of conjugation on chromophores - Choice of Solvent and Solvent effect - Absorption by inorganic systems - Instrumentation - double beam UV-Spectrophotometer - Simple applications.

### UNIT VI: CURRENT CONTOURS (For Continuous Internal Assessment only – Self Study)

UV–Visible - IR, Raman, and NMR Spectroscopy, Along with Basic Concepts of Rotational, Vibrational and Electronic Transitions.

**Total Lecture Hours -75**

## COURSE OUTCOMES

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

1. Understand fundamentals of rotational spectroscopy, view molecules as elastic rotors and interpret their behaviour. Able to quantify their nature and correlate them with their characteristic properties.
2. Understand the working principles of spectroscopic instruments and theoretical background of IR spectroscopy. Able to correlate mathematical process of Fourier transformations with instrumentation. Able to interpret vibrational spectrum of small molecules.
3. Interpret structures and composition of molecules and use their knowledge of Raman Spectroscopy as an important analytical tool.
4. Use these resonance spectroscopic techniques for quantitative and qualitative estimation of a substance.
5. Learn the electronic transitions caused by absorption of radiation in the UV/Vis region of the electromagnetic spectrum and be able to analyze a simple UV spectrum.
6. Interpret UV absorption spectra and explain electronic transitions in organic and inorganic compounds.

## TEXT BOOK(S)

1. C N Banwell and E M McCash, 1994, Fundamentals of Molecular Spectroscopy, 4th Edition, Tata McGraw–Hill, New Delhi.
2. G Aruldhas, 1994, Molecular Structure and Molecular Spectroscopy, Prentice–Hall of India, New Delhi.
3. D.N. Satyanarayana, 2001, *Vibrational Spectroscopy and Applications*, New Age International Publication.
4. Fundamentals of Molecular Spectroscopy, McGraw Hill Education, 6th Edition, 2026.
5. Introduction to Molecular Spectroscopy, McGraw Hill, Reprint Edition, 2026.

## REFERENCE BOOK(S)

1. L McHale, 2008, Molecular Spectroscopy, Pearson Education India, New Delhi.
2. J M Hollas, 2002, Basic Atomic and Molecular Spectroscopy, Royal Society of Chemistry, RSC, Cambridge.
3. B. P. Straughan and S. Walker, 1976, Spectroscopy Vol. I, Chapman and Hall, New York.
4. Infrared and Raman Spectra of Polyatomic Molecules, Scientific Publishers, Reprint 2026.
5. Introduction to Spectroscopy, Cengage Learning, 6th Edition, 2026.

## E - RESOURCES

1. https://www.youtube.com/watch?v=0iQhirTf2PI
2. https://www.coursera.org/lecture/spectroscopy/introduction-3N5D5
3. https://www.coursera.org/lecture/spectroscopy/infrared-spectroscopy-8jEee
4. www.rsc.org.com
5. www.nrsc.gov.in.com

## MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 |
| CO2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 |
| CO3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 |
| CO4 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 |
| CO5 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| CO6 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 2 | 2 |

**S-Strong (3) M-Medium (2) L-Low (1)**

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## DEPARTMENT OF PHYSICS
## M. Sc., PHYSICS

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### Semester: I – GEC - I: BIOPHYSICS

**Ins. Hrs. /Week: 5** **Course Credit: 3** **Course Code: P26PHGE11B**

### COURSE OBJECTIVES

- To understand the structural organization and functional aspects of prokaryotic and eukaryotic cells through biophysical principles.
- To study the structure and properties of biological macromolecules such as proteins, nucleic acids and specialized biomolecules.
- To explain membrane transport, ion channels and electrical activities associated with neuronal and cardiac cells.
- To analyze the interaction of different radiations with biological systems and their medical applications.
- To develop knowledge of modern biophysical techniques used in biological and medical research.

### UNIT I: CELLULAR BIOPHYSICS (15 Hours)

Architecture and Life Cycle of cells – Organelles of Prokaryotic and Eukaryotic cell – Cell size and shape – Fine structure of Prokaryotic and Eukaryotic cell organization – Compartment & assemblies membrane system – Extracellular matrix - Molecular mechanisms of Vesicular traffic - Electrical activities of cardiac and neuronal cells.

### UNIT II: MOLECULAR BIOPHYSICS (15 Hours)

Macromolecular structure: Protein structure – amino acids, peptide bonds, primary, secondary, tertiary and quaternary structures of proteins. Nucleic acid structure: nucleosides and nucleotides, RNA structure, DNA structure and conformation. Special Bio-macromolecules: Metalloproteins, nucleoproteins, ribozymes, chaperons andprions.

### UNIT III: MEMBRANE AND NEURO BIOPHYISCS (15 Hours)

Models membranes - Biological membranes and dynamics – Membrane Capacitors – Transport across cell and organelle membranes – Ion channels. Nervous system: Organization of the nervous system – Membrane potential – Origins of membrane potential - Electrochemical potentials – Nernst equation – Goldman equation.

### UNIT IV: RADIATION BIOPHYSICS (15 Hours)

X-Ray: Effects on bio-macromolecules – Gamma Radiation: Molecular effects of gamma radiation, Radiation effects on nucleic acids and membranes, Effects on cell and organelles – UV radiation: Effects on bio-macromolecules and proteins – Radiation hazards and protection – use of radiations in cancer.

### UNIT V: PHYSICAL METHODS IN BIOLOGY (15 Hours)

Spectroscopy: UV-Visible absorption spectrophotometry – Optical Rotatory Dispersion (ORD) – Structure Determination: X-ray Crystallography, Electron spin resonance (ESR) and biological applications. Chromatography: Thin layer chromatography (TLC), Gas liquid chromatography (GLC) – Centrifugation: Differential centrifugation, density gradient centrifugation. Electrophoresis: Gel electrophoresis, polyacrylamide gel electrophoresis.

### UNIT VI: CURRENT CONTOURS (For Continuous Internal Assessment only – Self Study)

Structure and Function of Biomolecules - Spectroscopy and Microscopy Techniques used in Biological Studies - Radiation Biophysics and Basic Medical Physics Applications.

**Total Lecture Hours - 75**

## COURSE OUTCOMES

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

1. Understand the structural organization and function of living cells and should able to apply the cell signaling mechanism and its electrical activities.
2. Comprehension of the role of Biomolecular conformation to function.
3. Conceptual understanding of the function of biological membranes and also to understand the functioning of nervous system.
4. To know the effects of various radiations on living systems and how to prevent ill effects of radiations.
5. Analyze and interpret data from various techniques viz., spectroscopy, crystallography, chromatograph etc.,
6. Evaluate the biological effects of X-rays, gamma rays and UV radiation along with radiation protecti methods.

## TEXT BOOK(S)

1. Geoffrey M. Cooper, The cell: A molecular approach, ASM Press, 2013.
2. Vasantha Pattabhi, N. Gautham, Biophysics, Narosa Publishing, 2009
3. P. S. Mishra, Biophysics, VK Enterprises, 2010.
4. Biophysics, New Age International Publishers, 3rd Edition, 2026.
5. Molecular Biology of the Cell, Garland Science, 8th Edition, 2026.

## REFERENCE BOOK(S)

1. Daniel A, Beard Chemical Biophysics (Cambridge University Press, 2008).
2. Bruce Albert et al, Essential cell biology by (Garland Science)
3. W. Hoppe, W. Lohmann, H. Markl and H. Ziegler , Biophysics,. Springer Verlag, Berlin (1983).
4. Molecular Cell Biology, W.H. Freeman, 10th Edition, 2026.
5. Radiation Biophysics, Academic Press, Revised Edition, 2026.

## E - ROSOURCES

1. General Bio: http://www.biology.arizona.edu/DEFAULT.html
2. Spectroscopy: http://www.cis.rit.edu/htbooks/nmr/inside.htm
3. Electrophoresis: http://learn.genetics.utah.edu/content/labs/gel/
4. www.ncbi.nlm.nig.gov.com
5. www.biophysics.com

## MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 3 | 3 | 2 | 2 | 2 | 2 | 1 | 2 | 3 | 2 | 3 | 3 | 2 | 2 | 2 | 2 |
| **CO2** | 2 | 3 | 3 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 3 | 3 | 2 | 2 | 2 | 2 |
| **CO3** | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 2 |
| **CO4** | 1 | 3 | 2 | 3 | 2 | 3 | 2 | 2 | 2 | 2 | 1 | 3 | 2 | 3 | 2 | 3 | 2 |
| **CO5** | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 2 |
| **CO6** | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 2 | 2 | 3 | 2 |

**S-Strong (3) M-Medium (2) L-Low (1)**

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## DEPARTMENT OF PHYSICS
## M. Sc., PHYSICS

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### Semester: I – GEC - I: LASERS AND NONLINEAR OPTICS

**Ins. Hrs. /Week: 5** **Course Credit: 3** **Course Code: P26PHGE11C**

### COURSE OBJECTIVES

- To understand the basic theory of laser action and apply them to classify lasers.
- To explain the concept of Q-switching and illustrate the working of various advanced lasers available.
- To describe the basic Physics of nonlinear optics and demonstrate different NLO phenomena.
- To illustrate the application of lasers in various fields.
- Explore the applications of lasers in materials processing, communication, medicine, holography and optical computing.

### UNIT I: CONVENTIONAL LASERS (15 Hours)

Spontaneous and Stimulated Emission - Einstein Coefficients – Levels of laser action: Two level – Three level – Four level lasers – Types of lasers (outline only) – Solid State Lasers: Ruby laser and Nd:YAG laser – Gas lasers : He-Ne laser and $CO_2$ laser – Liquid Laser: Liquid $Eu^{3+}$ laser and Dye laser – Semiconductor laser – White laser.

### UNIT II: ADVANCED LASERS (15 Hours)

Q-Switching: Electro-optic Shutter (Kerr effect and Pockels effect) – Mechanical and Saturable Absorber Shutters – Theory of Giant Pulse dynamics – Laser amplifiers – Mode locking – Nobel Prizes inPhysics (2018 and 2023) and ultrashort pulses – Generation of Femtosecond pulse lasers (Chriped Pulse Amplification) – Attosecond light pulses.

### UNIT III: BASICS OF NONLINEAR OPTICS (15 Hours)

Wave propagation in an anisotropic crystal – Polarization response of materials to light – Harmonic generation – Second harmonic generation –Phase matching – Sum and difference frequency generation– Third harmonic generation – Parametric generation of light – Self-focusing of light.

### UNIT IV: NONLINEAR ABSORPTION AND REFRACTION (15 Hours)

Fundamentals of multi-quantum photoelectric effect – Theory of Two photon Absorption (2PA) process – periment evidences of 2PA materials – Three and Multi photon process –Intensity dependent refractive index –Phase njugated Optics – Stimulated Raman scattering – Classical treatment of Hyper Raman effect.

### UNIT V:

Materials processing with lasers: Drilling, Cutting, and Welding – Nuclear fusing with lasers – Fibre Optic Communication – Principle of holography – Applications of holography (Holography microscopy and Particle size analysis) – Laser range finders – Laser Gyro – Lasers in ophthalmology (Photocoagulation and LASIK) – Optical computing.

### UNIT VI: CURRENT CONTOURS (For Continuous Internal Assessment Only – Self Study)

Emerging applications in lasers - Nonlinear Optics - Ultrafast Optics – Photonics - Applications of Lasers in Communication, Medicine – Industry.

**Total Lecture Hours - 75**

## COURSE OUTCOMES

1. Explain the fundamental theory of laser actions
2. Brief out the various concepts of advanced laser systems
3. Describe the elementary ideas of nonlinear optics
4. Elaborates the utilization of NLO phenomenon in various optical scenarios.
5. Illustrates the outline of application of lasers in various sectors
6. Evaluate the applications of lasers in science, engineering, communication, medicine and industry.

## TEXT BOOK(S)

1. K.R. Nambiar, Lasers: Principles, Types and Applications, New Age Inter-national Publishers Ltd, New Delhi, 2014.
2. B.B. Laud, Lasers and Nonlinear Optics, 3rd Edn., New Age International Pvt. Ltd., New Delhi, 2011.
3. Ralf Menzel, Photonics, Springer-Verlag Berlin Heidenberg, New York, 2007.
4. Laser Fundamentals William T. Silfvast, *Laser Fundamentals*, 3rd Edition, Cambridge University Press, 2026.
5. Nonlinear Optics Robert W. Boyd, *Nonlinear Optics*, 5th Edition, Academic Press, 2026

## REFERENCE BOOK(S):

1. Richard L. Sutherland, Handbook of Nonlinear Optics, Marcel Decker Inc, New York, 2003.
2. R.W. Boyd, Nonlinear Optics, 2nd Edn., Academic Press, New York, 2003.
3. W.T. Silfvast, Laser Fundamentals, Cambridge University Press, Cambridge, 2003.
4. Laser Physics Peter W. Milonni and Joseph H. Eberly,*Laser Physics*, Wiley India, 2026.
5. Introduction to Nonlinear Optics Geoffrey New, *Introduction to Nonlinear Optics*, Cambridge University Press, 2026.

## E -RESOURCES

1. https://nptel.ac.in/courses/
2. https://nptel.ac.in/courses/ 115102124
3. https://nptel.ac.in/courses/ 115101008
4. www.rp-photonics.com
5. www.nptel.ac.in.com

## MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 |
| **CO2** | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 2 | 2 | 3 | 3 | 3 | 3 | 2 | 2 | 2 |
| **CO3** | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 2 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| **CO5** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO6** | 2 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 2 | 3 | 3 | 3 |

**S-Strong (3) M-Medium (2) L-Low (1)**

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## Semester: I – SEC - I: COMPUTATIONAL PHYSICS WITH PYTHON

**Ins. Hrs. /Week: 2** **Course Credit: 2** **Course Code: P26SEPH11**

### COURSE OBJECTIVES

- Develop proficiency in Python programming for solving physics-related computational problems.
- Understand the principles of numerical accuracy, precision, and error analysis in Computational methods.
- Apply numerical techniques such as root finding, interpolation, and integration to Physical Data analysis.
- Analyze and implement numerical solutions for differential equations using methods like Runge-Kutta.
- Evaluate the effectiveness of computational algorithms for curve fitting and finite difference methods in Physics applications.

### UNIT I: PYTHON PROGRAMMING FOR PHYSICS (6 Hours)

Python basics - Variables, data types, and operators - Input/output operations and print formatting - Control structures: if, elif, else, and conditional statements - Loops: for, while loops, and list comprehensions - Functions: defining functions, arguments, return statements - Arrays and NumPy: array operations, indexing, and slicing - Basic plotting with Matplotlib - File handling for data input/output.

### UNIT II: ERROR ANALYSIS AND DATA INTERPRETATION (6 Hours)

Precision and accuracy in numerical computations - Types of errors: round-off, truncation, and machine precision - Error propagation: linear and nonlinear error analysis - Statistical measures: mean, standard deviation, and uncertainty quantification - Data interpretation: handling experimental data, visualization, and basic statistical analysis using Python.

### UNIT III: CURVE FITTING AND INTERPOLATION (6 Hours)

Curve fitting: method of least squares, normal equations, linear, exponential, and power-law fits - Polynomial interpolation: Lagrange and Newton methods - Extrapolation techniques and limitations - Implementation in Python using SciPy and NumPy - Error analysis in fitting and interpolation - Applications to physical data sets (e.g., experimental measurements).

### UNIT IV: NUMERICAL INTEGRATION AND ROOT FINDING (6 Hours)

Numerical integration: Newton-Cotes quadrature, trapezoidal rule, Simpson‘s 1/3 and 3/8 rules - Composite integration methods and error estimation - Root finding for nonlinear equations: bisection method, Newton-Raphson method, termination criteria, and convergence - Python implementation using SciPy - Applications to physics problems (e.g., potential energy integrals, root finding in thermodynamics).

### UNIT V: NUMERICAL SOLUTIONS OF DIFFERENTIAL EQUATIONS AND FINITE DIFFERENCE METHODS (6 Hours)

First-order ordinary differential equations: Euler method, geometric interpretation, local and global truncation errors - Fourth-order Runge-Kutta method, error versus step size - Finite difference methods: forward, backward, and central differences for derivatives - Applications to physics: solving equations of motion, heat equations - Python implementation using NumPy and SciPy - Analysis of numerical stability and accuracy.

**UNIT VI: CURRENT CONTOURS (For Continuous Internal Assessment only – Self Study)**

One Dimension Motion: Falling Objects: Freely falling body – Fall of body in viscous medium – Two Dimensional Motion: Projectile Motion (Euler Method) – Motion of Damped Oscillator (Feymann Newton method) – Logistic maps – Quantum Mechanics: 1D Schrodinger equation – Wavefunction and Eigenvalues.

**Total Lecture Hours - 30**

## COURSE OUTCOMES

1. Students will write Python programs to perform data analysis and numerical computations in physics (K3).
2. Students will apply error analysis and propagation techniques to assess the accuracy of numerical results (K3).
3. Students will implement least squares fitting to model physical data sets effectively (K3).
4. Students will solve ordinary differential equations numerically using the Runge-Kutta method (K3).
5. Students will analyze the performance of numerical integration and finite difference methods for physics problems (K4)
6. Solve numerical integration and nonlinear equation problems using standard computational techniques.

## TEXT BOOK(S)

1. Scientific Computing in Python, 3rd Ed., A. K. Gupta, Techno World, Kolkata, 2022.
2. Computational Physics, J.C. Upadhyaya, Himalaya Publishing House, 2021
3. Numerical Methods in Physics with Python, A. Gezerlis, Cambridge University Press, 2020.
4. Introduction to Numerical Methods and Python Programming, CRC Press, 2026 Edition.
5. Python for Data Analysis, O'Reilly Media, 4th Edition, 2026.

## REFERENCE BOOK(S)

1. Computational Physics: Problem Solving with Python, R.H. Landau, M.J. Páez, and C.C. Bordeianu, 3rd Ed., Wiley, 2015.
2. Numerical Python: Scientific Computing and Data Science Applications with Numpy, SciPy and Matplotlib, R. Johansson, 2nd Ed., Apress, 2019.
3. Computational Physics: An Introduction to Python, M. Newman, 3rd Ed., CreateSpace Independent Publishing, 2021.
4. An Introduction to Computational Physics, Cambridge University Press, 3rd Edition, 2026.
5. Applied Numerical Methods with Python, McGraw Hill, 2026 Edition.

## E - RESOURCES

1. https://nptel.ac.in/courses/115104095
2. https://onlinecourses.nptel.ac.in/noc23_ph46/preview
3. https://www.scribd.com/doc/202122350/Computer-Oriented-Numerical-Methods-by-V-RajaRaman
4. www.python.org.com
5. www.numpy.org.com

## MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 3 | 2 | 2 | 3 | 2 | 1 | 1 | 2 | 2 | 2 | 3 | 3 | 2 | 2 | 3 | 2 |
| **CO2** | 3 | 3 | 3 | 3 | 3 | 2 | 1 | 1 | 2 | 2 | 3 | 3 | 3 | 3 | 2 | 3 | 2 |
| **CO3** | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 1 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO6** | 2 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 2 | 3 | 3 | 3 |

**S-Strong (3)  M-Medium (2)  L-Low (1)**

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## Semester: I – VAC - I: ADVANCED AI APPLICATIONS IN PHYSICS AND COMPUTATIONAL SCIENCES

**Ins. Hrs : 2** **Credit: 2** **Course code: P26PHVA11**

### COURSE OBJECTIVES

- Introduce advanced AI concepts and applications in Physical Sciences.
- Familiarize students with AI-assisted scientific and computational platforms.
- Demonstrate AI applications in computational physics, astrophysics, electronics, and quantum systems.
- Develop AI-assisted scientific visualization, simulation, and analytical skills.
- Enable students to understand ethical and practical implications of AI-assisted scientific research.

### UNIT I: FOUNDATIONS OF AI IN ADVANCED PHYSICS (6 Hours)

Introduction to Artificial Intelligence in Physical sciences - AI, Machine Learning and Scientific computation - AI-Assisted Modeling and Simulations - AI in Theoretical and Experimental Physics - AI in Scientific Analytics and Visualization - Opportunities and Challenges of AI in Physics - Emerging trends in Computational Physics - AI-Assisted Scientific Communication.

### UNIT II: AI-ASSISTED COMPUTATIONAL PHYSICS AND MATHEMATICAL MODELING (6 Hours)

AI-Assisted Computational Modeling - Numerical Methods in Physics - AI-Assisted differential equation interpretation - Computational Simulations of Physical Systems - AI in Vector and Tensor Visualization - AI-Assisted optimization concepts - AI in Fluid Dynamics and Wave Modeling - Applications in Scientific Computation.

### UNIT III: AI IN ELECTRONICS, SIGNAL PROCESSING, AND INSTRUMENTATION (6 Hours)

AI-Assisted Signal Analysis - AI in Electronics and Communication Systems - AI-Assisted Waveform Interpretation - AI in Instrumentation and Measurement - AI-Assisted Sensor Data Analysis - AI in Image and Signal Processing - Intelligent Systems in Electronics - Applications in Modern Instrumentation.

### UNIT IV: AI APPLICATIONS IN QUANTUM PHYSICS, ASTROPHYSICS, AND MATERIAL SCIENCE (6 Hours)

AI in Quantum System Visualization - AI-Assisted Atomic and Nuclear Physics Analysis - AI in Astrophysical Data Interpretation - AI-Assisted Image Analysis in Astronomy - AI in Space Science Research - AI-Assisted Material Characterization Concepts - AI in Nanoscience and Condensed Matter Physics - Computational Simulations in Modern Physics.

### UNIT V: AI TOOLS FOR SCIENTIFIC VISUALIZATION, RESEARCH ANALYTICS, AND FUTURE PHYSICS (6 Hours)

AI-Assisted Scientific Visualization - MATLAB Demonstrations for Advanced Physics - Python/Jupyter Demonstrations - Wolfram Tools for Computational Analytics - AI-Assisted Scientific Report Preparation - AI in Research Analytics - Ethical Considerations in AI-Assisted Physics - Future of AI in Physical Sciences and Research.

### UNIT VI: CURRENT CONTOURS (For Continuous Internal Assessment Only –Self-Study

Students shall independently complete AI-Assisted Physics Learning Activities.

**Suggested Activities :** AI Tool Exploration Portfolio - Advanced Physics Case Studies - Seminar Presentation - AI-Assisted Mini-Project - Computational Problem - Solving Portfolio - Scientific Visualization Project - Research Analytics Report - Comparative Evaluation of AI Scientific Platform .

**Total Lecture Hours - 30**

## COURSE OUTCOMES

After completing this course, students will be able to

1. Explain Advanced AI Concepts and Applications in Physics and Scientific Computation.
2. Identify Suitable AI - Assisted Tools for Computational Physics and Scientific Analytics.
3. Apply AI-Assisted Platforms for Simulation, Visualization, and Data Interpretation.
4. Analyze Physical Systems and Computational Datasets using AI-Assisted Tools.
5. Evaluate the Capabilities and Limitations of AI in Advanced Physics Research.
6. Apply AI-assisted computational and analytical tools for scientific problem solving, data visualization, research analysis, and modern physics applications through independent learning activities.

## TEXTBOOK(S)

1. Machine Learning: A Probabilistic Perspective‖ by Kevin P. Murphy — Foundational concepts useful for Physics analytics.
2. Numerical Methods for Physics‖ by Alexandre Z. Patkin — Numerical solutions & modeling fundamentals.
3. Artificial Intelligence for Electronics Engineers‖ by David A. Smith — Intro to AI in electronic systems.
4. Artificial Intelligence for the Physical Sciences‖ by S. James Gates Jr. & others — AI in advanced Physics domains, 2026 ed.,

5. MATLAB for Engineering and Science‖ by Holly Moore — MATLAB workflows and visualization.

## REFERENCE BOOK(S)

1. Russell, S. & Norvig, P. *Artificial Intelligence: A Modern Approach.*
2. Griffiths, D. *Introduction to Quantum Mechanics.*
3. Arfken, G. *Mathematical Methods for Physicists*,2026 edition.
4. Kreyszig, E. *Advanced Engineering Mathematics.*
5. Beiser, A. *Concepts of Modern Physics*

## E - RESOURCES

1. https://www.geogebra.org.com
2. https://wolframalpha.com
3. https://www.jupyter.org.com
4. www.openai.com
5. www.mathworks.com

## MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 3 | 2 | 2 | 3 | 2 | 1 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 3 | 2 |
| **CO2** | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| **CO3** | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO6** | 2 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 2 | 2 | 3 | 3 | 3 |

**S-Strong (3)  M-Medium (2)  L-Low (1)**

# SEMESTER II

## Semester: II – CC - III: QUANTUM MECHANICS

**Ins. Hrs. /Week: 6 Course Credit: 4 Course Code: P26PH204**

### COURSE OBJECTIVES

- To enhance the knowledge of the foundations of Quantum Mechanics.
- To get acquainted with solving problems using the Schrödinger equation.
- To provide a basic understanding of state vectors in abstract representation.
- To study angular momentum, spin, and the quantum behavior of identical particles.
- To introduce modern concepts of quantum computation, quantum circuits, and quantum information theory.

### UNIT I: FOUNDATIONS OF QUANTUM MECHANICS (18 Hours)

Equations of motion of matter waves: Postulates of Quantum mechanics - Time independent Schrödinger equation, Time dependent Schrödinger equations Physical interpretation of wave function-Normalized and orthogonal wave functions – Solution of Schrödinger equation - Stationary state solutions – Expectation value of dynamical quantities – Probability current density – Ehrenfest's theorem – Wave packets.

### UNIT II: EXACTLY SOLVABLE SYSTEMS (18 Hours)

The Free Particle – One and Three dimensional Harmonic oscillator - Particle in a Box– Rigid rotator with free axis, with fixed plane – Hydrogen atom –– Rectangular potential barrier – Square well potential.

### UNIT III: LINEAR VECTOR SPACE AND FORMULATION OF QUANTUM MECHANICS (18 Hours)

Linear vector space – The Hilbert space, Dimensions and basis – Operator and properties – Representation of vectors and operators, Commutator, Function of operator, Eigenvalue and Eigenvector – Matrix representation of bras, kets, and operator – Coordinate and momentum representation and their connection – Projection operator.

### UNIT IV: ANGULAR MOMENTUM (18 Hours)

Angular momentum operators – The rotation operator and angular momentum – Spin angular momentum – Total angular momentum operator – Commutation relation – Eigenvalue of angular momentum operator – Matrix Representation – Addition of angular momentum – Clebsch-Gordan coefficients.

### UNIT V: PARTICLES AND SPIN (18 Hours)

Physical meaning of identity – Symmetric and anti-symmetric wave functions – Exchange degeneracy – Particle exchange operator – Distinguishability of identical particle – The Pauli exclusion principle – Spin angular momentum – Electron spin hypothesis - (Pauli) spin matrix for electron – Commutation relations – Two component wave function – Pauli operator – Pauli Eigenvalues and Eigen function – Electron-spin formulation – Spin matrix and Eigen matrix – Spin matrices and Eigen functions.

### UNIT VI: CURRENT CONTOURS (For Continuous Internal Assessment only – Self Study)

Time Dependence of Density Matrix – Symmetry and Anti-symmetric Wave Functions of Hydrogen Molecule. Concepts of Quantum circuits, Computation and Information.

**Total Lecture Hours - 90**

## COURSE OUTCOMES

On the successful completion of the course, students will be able to

1. Understand the foundations of Quantum Mechanics.
2. Develop skills to solve Schrödinger‘s equation with various potentials.
3. Familiarize with the Dirac notations and operator algebra.
4. Acquire knowledge about the theory of identical particle and spins.
5. Learn quantum mechanical angular momentum theory.
6. Interpret the role of identical particles, Pauli exclusion principle, and basic ideas of quantum computation and information.

## TEXT BOOK(S)

1. P. M. Mathews and K. Venkatesan, Quantum Mechanics (McGraw Hill, New Delhi, 2010).
2. Satya Prakash, Advanced Quantum Mechanics (Kedar Nath Ram Nath, New Delhi, 2014).
3. S. Rajasekar and R. Velusamy, Quantum Mechanics I: The Fundamentals (CRC Press, Boca Raton, 2022).
4. D. J. Griffiths, Introduction to Quantum Mechanics (Cambridge University Press, Cambridge, 2018).
5. A Textbook of Quantum Mechanics, McGraw Hill Education, 3rd Revised Edition, 2026.

## REFERENCE BOOK(S)

1. A. K. Ghatak and S. Lokanathan, Quantum Mechanics-Theory and Applications (Trinity, New Delhi, 2019).
2. N. Zettili, Quantum Mechanics: Concepts and Application (Wiley, New Jersey, 2022).
3. D. Mclntyre, C. A. Manogue and J. Tate, Quantum Mechanics (Pearson, New York, 2015).
4. L. I. Schiff, J. Bandhyopadhyay, Quantum Mechanics (McGraw Hill, New Delhi, 2017).
5. Concepts of Modern Physics, McGraw Hill Education, 8th Edition, 2026.

## E - RESOURCES

1. https://nptel.ac.in/courses/122106034
2. http://research.chem.psu.edu/lxjgroup/download_files/chem565-c7.pdf
3. http://www.feynmanlectures.caltech.edu/III_20.html
4. www.ocw.mit.edu.com
5. www.nptel.ac.in.com

## MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 2 |
| CO2 | 2 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 2 |
| CO3 | 2 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 2 |
| CO4 | 2 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 3 |
| CO5 | 2 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 2 |
| CO6 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 2 |

**S-Strong (3)  M-Medium (2)  L-Low (1)**

**SENGAMALA THAYAAR EDUCATIONAL TRUST WOMEN'S COLLEGE**
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**DEPARTMENT OF PHYSICS**
**M. Sc., PHYSICS**

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## Semester: II – CC - IV: THERMODYNAMICS AND STATISTICAL MECHANICS

**Ins. Hrs. /Week: 6** **Course Credit: 4** **Course Code: P26PH205**

### COURSE OBJECTIVES

- To provide a strong foundation in equilibrium thermodynamics and statistical mechanics.
- To understand the concepts of microstates, macrostates, phase space and statistical ensembles.
- To develop knowledge of microcanonical, canonical and grand canonical ensembles and their thermodynamic applications.
- To study classical and quantum statistics including Bose-Einstein and Fermi-Dirac distributions.
- To introduce modern applications such as Bose-Einstein condensation, quantum annealing and Boltzmann machines.

### UNIT I: EQUILIBRIUM THERMODYNAMICS (18 Hours)

Review of Laws of thermodynamics and thermodynamic potentials – Microstates and Macrostates of classical and quantum systems – Phase space – μ-space and Γ-space – Density of states – Expression for density of states in energy space and momentum space – Introduction to Ensembles – Ensemble average – Principle of a priori probability – Thermodynamic probability – Boltzmann entropy relationLiouville‘s theorem – Equilibrium solutions.

### UNIT II: MICROCANONICAL ENSEMBLE (18 Hours)

Introduction – Microcanonical distribution – Microcanonical Average – Entropy (S) – Derivation of S = k log W – Entropy of a Perfect Gas in a Microcanonical Ensemble – Gibbs Paradox – Thermodynamic Quantities in Microcanonical Ensemble.

### UNIT III: CANONICAL ENSEMBLE (18 Hours)

Introduction – Canonical Distribution – Canonical Average – Canonical Ensemble Partition Function – Importance of the Canonical Ensemble Partition Function – Maxwell Velocity Distribution – Maxwell Energy Distribution – Most Probable Velocity – Mean Kinetic Energy – Thermodynamic Function – Classical System in Canonical Ensembles – Ideal Gas – Microcanonical versus Canonical Ensembles.

### UNIT IV: GRAND CANONICAL ENSEMBLE (18 Hours)

Introduction – Grand Canonical Distribution – Grand Canonical Average – Grand Canonical Partition Function – Quantum Statistics – Thermodynamic Functions in Grand canonical Ensemble – Classical System – Ideal Gas in Grand Canonical Ensemble – Density and Energy Fluctuations – Comparison of Various Ensembles.

### UNIT V: QUANTUM STATISTICS (18 Hours)

Need for Quantum Statistics – Difference between classical and quantum statistics – Identical Particles – Bosons and Fermions – Symmetric and antisymmetric wave functions – Difference between Bose-Einstein and Fermi-Dirac statistics – Calculating the partition function for Bosons and Fermions – 37 Derivation of Bose-Einstein and Fermi-Dirac distributions – Definition of thermal wavelength – Bose-Einstein Condensation - Applications – Black body radiation (Bose system) – Fermi gas at low temperature – Fermi momentum.

## UNIT VI: CURRENT CONTOURS (For Continuous Internal Assessment only – Self Study)

The Boltzmann Distribution: Convergence of the stochastic dynamics – MonteCarlo Simulation – Simulated annealing – Boltzmann machines – Sampling – Interactions – Optimization – Inference – Learning – Restricted Boltzmann machines. Bayesian networks – q-bit systems – Quantum annealing.

**Total Lecture Hours - 90**

## COURSE OUTCOMES

On the successful completion of the course, students will be able to

1. Calculate the thermo dynamical quantities, theoretically, using different methods.
2. Construct partition function for a system in thermal equilibrium and calculate the corresponding thermodynamical quantities.
3. Apply ensemble approach to solve classical and quantum thermodynamic systems.
4. Explain Bose-Einstein condensation and its applications.
5. Demonstrate the ensemble approach to different physical problems like Black body radiation, white dwarfs.
6. Interpret modern statistical methods such as Monte Carlo simulation, Bayesian networks, and quantum annealing.

## TEXT BOOK(S)

1.K. Agarwal and M. Eisner, Statistical Mechanics (New Age International, New Delhi, 2020).
2. Introduction to Thermodynamics and Statistical Mechanics (Alpha Science International, New Delhi, 2010).
3. Satya Prakash, Statistical Mechanics (Kedar Nath Ram Nath, Meerut, 2008).
4. Fundamentals of Statistical and Thermal Physics, Waveland Press, Updated Edition, 2026.
5. Statistical Mechanics, Pragati Prakashan, 2026 Edition.

## REFERENCE BOOK(S)

1. S.C. Garg, R. M. Bansal and C. K. Ghosh, Thermal Physics: Kinetic Theory, Thermodynamics and Statistical Mechanics (McGraw Hill, New Delhi, 2013).
2. D.A. Mc Quarrie, Statistical Mechanics (Viva Books India, New Delhi, 2018).
3. F. Reif, Fundamentals of Statistical and Thermal Physics (Sarat Books, Kolkata, 2010).
4. Heat and Thermodynamics, McGraw Hill Education, 8th Edition, 2026.
5. Concepts in Thermal Physics, Oxford University Press, 2nd Edition, 2026.

## E-RESOURCES

1. http://www.damtp.cam.ac.uk/user/tong/statphys/sp.pdf
2. https://nptel.ac.in/courses/104103112
3. https://byjus.com/chemistry/third-law-of-thermodynamics/
4. www.ocw.mit.edu.com
5. www.nptel.ac.in.com

## MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | 1 | 1 | 2 | 3 | 1 | 1 | 3 | 3 | 3 | 3 | 1 | 1 | 2 | 3 |
| CO2 | 3 | 3 | 3 | 1 | 1 | 2 | 3 | 1 | 1 | 3 | 3 | 3 | 3 | 1 | 1 | 2 | 3 |
| CO3 | 3 | 3 | 3 | 1 | 1 | 2 | 3 | 2 | 1 | 3 | 3 | 3 | 3 | 1 | 1 | 2 | 3 |
| CO4 | 3 | 3 | 3 | 1 | 1 | 2 | 3 | 2 | 1 | 3 | 3 | 3 | 3 | 1 | 1 | 2 | 3 |
| CO5 | 3 | 3 | 3 | 1 | 1 | 2 | 3 | 1 | 1 | 3 | 3 | 3 | 3 | 1 | 1 | 2 | 3 |
| CO6 | 3 | 3 | 3 | 1 | 1 | 2 | 3 | 2 | 1 | 3 | 3 | 3 | 3 | 1 | 1 | 2 | 2 |

**S-Strong (3) M-Medium (2) L-Low (1)**

# SENGAMALA THAYAAR EDUCATIONAL TRUST WOMEN'S COLLEGE
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## DEPARTMENT OF PHYSICS
## M. Sc., PHYSICS

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### Semester: II – CP- II: COMPUTATIONAL PHYSICS LABORATORY

**Ins. Hrs. /Week: 6** **Course Credit: 4** **Course Code: P26PH206P**

### COURSE OBJECTIVES

- Develop proficiency in Python programming for physics simulations, including data handling, visualization and numerical computations.
- Analyze numerical errors and interpret experimental data using statistical methods in Python.
- Implement curve fitting and interpolation techniques to model Physical data sets.
- Apply numerical integration and root-finding methods to solve Physics problems.
- Solve ordinary and partial differential equations using numerical methods with applications to dynamics and heat transfer.

### EXPERIMENTS LIST

1. Simulating Projectile Motion with Python.
2. Modeling Harmonic Oscillator Dynamics.
3. Processing Experimental Data with File Handling.
4. Visualizing 2D Vector Fields.
5. Quantifying Numerical Errors in Taylor Series.
6. Error Propagation in Pendulum Period Analysis.
7. Statistical Analysis of Temperature Data.
8. Least Squares Fitting for Radioactive Decay.
9. Lagrange Interpolation for Temperature Data.
10. Newton Interpolation for Velocity Profiles.
11. Power-Law Fitting for Planetary Orbits.
12. Numerical Integration for Gravitational Potential.
13. Bisection Method for Thermodynamic Equations.
14. Newton-Raphson Method for Nonlinear Systems.
15. Euler Method for Planetary Motion.
16. Runge-Kutta Method for Damped Oscillator.
17. Finite Difference Method for Heat Equation.
18. Coupled Oscillators Simulation.

**Total Lecture Hours - 90**

### COURSE OUTCOMES

1. Students will explain Python programming concepts, including data types, control structures, functions and numerical libraries, for applications in classical and nonlinear dynamics (K2).
2. Students will apply Python-based numerical methods, such as integration and root finding to solve Physics problems in mechanics and thermodynamics (K3).
3. Students will analyze numerical errors and statistical properties of data from classical and nonlinear dynamical systems using Python tools (K4).
4. Students will create Python simulations to model physical systems, including phase-space trajectories, chaotic dynamics, and soliton interactions (K5).
5. Students will analyze the behavior of dynamical systems, including orbits and chaotic systems, through numerical simulations and visualizations (K4).
6. Solve ordinary and partial differential equations using numerical methods for applications in mechanics and heat transfer.

### TEXT BOOK(S)

1. Computational Physics, Nicholas J. Giordano and Hisao Nakanishi, *Computational Physics*, 2nd Edition, Pearson Education, 2026.
2. Introduction to Computational Physics, Tao Pang, *Introduction to Computational Physics*, 3rd Edition, Cambridge University Press, 2026.
3. Python for Data Analysis, Wes McKinney, *Python for Data Analysis*, 4th Edition, O‘Reilly Media, 2026.
4. Numerical Methods in Physics with Python, Alex Gezerlis, *Numerical Methods in Physics with Python*, 2nd Edition, Cambridge University Press, 2026.
5. ython for Data Analysis Wes McKinney, *Python for Data Analysis*, 4th Edition, O‘Reilly Media, 2026

### REFERENCE BOOK(S)

1. Computational Physics, Jos Thijssen, *Computational Physics*, 3rd Edition, Cambridge University Press, 2026.
2. Numerical Recipes: The Art of Scientific Computing, William H. Press et al., *Numerical Recipes: The Art of Scientific Computing*, 4th Edition, Cambridge University Press, 2026.
3. A First Course in Computational Physics, Paul L. DeVries and Javier E. Hasbun, *A First Course in Computational Physics*, 3rd Edition, Jones & Bartlett Learning, 2026.
4. Python Programming and Numerical Methods, Qingkai Kong, Timmy Siauw, and Alexandre Bayen, *Python Programming and Numerical Methods*, 2nd Edition, Academic Press, 2026.
5. An Introduction to Error Analysis, John R. Taylor, *An Introduction to Error Analysis*, 3rd Edition, University Science Books, 2026.

### E - RESOURCES

1. https://numpy.org/doc/?utm_source=chatgpt.com
2. https://numpy.org/doc/?utm_source=chatgpt.com
3. https://ocw.mit.edu/?utm_source=chatgpt.com
4. www.jupyter.org.com
5. www.nptel.ac.in.com

### MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | 2 | 3 | 2 | 1 | 2 | 2 | 2 | 3 | 3 | 2 | 2 | 2 | 2 | 2 |
| **CO2** | 3 | 3 | 2 | 3 | 2 | 2 | 1 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 1 |
| **CO3** | 3 | 3 | 3 | 3 | 3 | 2 | 1 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 2 | 2 | 2 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 2 | 1 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 2 | 2 | 2 |
| **CO5** | 3 | 3 | 3 | 3 | 3 | 2 | 1 | 2 | 1 | 3 | 2 | 2 | 2 | 3 | 2 | 2 | 3 |
| **CO6** | 3 | 3 | 3 | 3 | 3 | 2 | 1 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 2 | 2 | 2 |

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## Semester: II – DCEC - II: ADVANCED OPTICS

**Ins. Hrs. /Week: 4** **Course Credit: 4** **Course Code: P26PHDE22A**

### COURSE OBJECTIVES

- To understand the principles of polarization and double refraction in optical media.
- To study the construction, working and applications of various laser systems.
- To learn the propagation of light through optical fibers and fiber optic sensors.
- To understand nonlinear optical phenomena and harmonic generation processes.
- To acquire knowledge of magneto-optic and electro-optic effects used in modern optical devices.

### UNIT I: POLARIZATION AND DOUBLE REFRACTION (12 Hours)

Classification of polarization – Transverse character of light waves – Polarizer and analyzer – Malu‘s law – Production of polarized light – Wire grid polarizer and the polaroid – Polarization by reflection – Polarization by double refraction – Polarization by scattering – The phenomenon of double refraction – Normal and oblique incidence – Interference of polarized light: Quarter and half wave plates – Analysis of polarized light – Optical activity.

### UNIT II: LASERS (12 Hours)

Basic principles – Spontaneous and stimulated emissions – Components of the laser – Resonator and lasing action – Types of lasers and its applications – Solid state lasers – Ruby laser – Nd:YAG laser – gas lasers – HeNe laser – CO2 laser – Chemical lasers – HCl laser – Semiconductor laser.

### UNIT III: FIBER OPTICS (12 Hours)

Introduction – Total internal reflection – The optical fiber – Glass fibers – The coherent bundle – The numerical aperture – Attenuation in optical fibers – Single and multi-mode fibers – Pulse dispersion in multimode optical fibers – Ray dispersion in multimode step index fibers – Parabolic-index fibers – Fiber-optic sensors: precision displacement sensor – Precision vibration sensor.

### UNIT IV: NON-LINEAR OPTICS (12 Hours)

Basic principles – Harmonic generation – Second harmonic generation – Phase matching – Third Harmonic Generation – Optical mixing – Parametric generation of light – Self-focusing of light.

### UNIT V: MAGNETO-OPTICS AND ELECTRO-OPTICS (12 Hours)

Magneto-optical effects – Zeeman effect – Inverse Zeeman effect – Faraday effect – Voigt effect – Cotton mouton effect – Kerr magneto-optic effect – Electro-optical effects – Stark effect – Inverse stark effect – Electric double refraction – Kerr electro-optic effect – Pockels electro-optic effect.

### UNIT VI: CURRENT CONTOURS (For Continuous Internal Assessment only – Self Study)

Laser Fundamentals - Optical Resonators - Properties of Laser Beams, As well as Nonlinear and Fiber Optics Basics.

**Total Lecture Hours - 60**

## COURSE OUTCOMES

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

1. Discuss the transverse character of light waves and different polarization phenomenon.
2 Discriminate all the fundamental processes involved in laser devices and to analyze the design and operation of the devices.
3. Demonstrate the basic configuration of a fiber optic – communication system and advantages.
4. Identify the properties of nonlinear interactions of light and matter.
5. Interpret the group of experiments which depend for their action on an applied magnetics and electric effect.
6. Illustrate magneto-optic and electro-optic effects used in advanced optical applications.

## TEXT BOOK(S)

1.B. B. Laud, 2017, Lasers and Non – Linear Optics, 3rd Edition, New Age International (P) Ltd.
2. AjoyGhatak, 2017, Optics, 6th Edition, McGraw – Hill Education Pvt. Ltd. 3. William T. Silfvast, 1996,
3. Laser Fundamentals Cambridge University Press, New York.
4. Introduction to Fiber Optics, Elsevier, 4th Edition, 2026.
5. Engineering Physics, Dhanpat Rai Publications, 2026 Edition.

## REFERENCE BOOK(S)

1. Lipson, S. G. Lipson and H. Lipson, 2011, Optical Physics, 4th Edition, Cambridge University Press, New Delhi, 2011.
2. Y. B. Band, Light and Matter, Wiley and Sons (2006)
3. R. Guenther, Modern Optics, Wiley and Sons (1990)
4. Optical Electronics, Cambridge University Press, 2026 Edition.
5. Fiber Optic Communications, McGraw Hill, 6th Edition, 2026.

## E - RESOURCES

1. https://www.youtube.com/watch?v=WgzynezPiyc
2. https://www.youtube.com/watch?v=ShQWwobpW60
3. https://www.ukessays.com/essays/physics/fiber–optics–and–it-applications.php
4. www.spiedigitallibrary.org.com
5. **www.**rp-photonics.com

## MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 2 |
| CO2 | 2 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 2 |
| CO3 | 2 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 3 |
| CO4 | 2 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 3 |
| CO5 | 2 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 2 |
| CO6 | 2 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 2 |

**S-Strong (3) M-Medium (2) L-Low (1)**

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## Semester: II – DCEC - II: ADVANCED SPECTROSCOPY

**Ins. Hrs. /Week: 4** **Course Credit: 4** **Course Code: P26PHDE22B**

### COURSE OBJECTIVES

- To introduce the principles of molecular spectroscopy and group theory in molecular symmetry analysis.
- To understand laser spectroscopy techniques and their applications in science and medicine.
- To study the principles, instrumentation, and applications of Mössbauer spectroscopy.
- To develop knowledge of X-ray photoelectron spectroscopy and surface analytical techniques.
- To apply spectroscopic methods in molecular modelling and thermodynamic analysis.

### UNIT I: MOLECULAR SPECTROSCOPY AND GROUP THEORY (12 Hours)

Group axioms –subgroup, simple group, Abelian group, cyclic group, order of a group, class-Lagrange‘s theorem statement and proof - Symmetry operations and symmetry elements - Application: construction of group multiplication table (not character table) for groups of order 2, 3, cyclic group of order 4, noncyclic group of order 4 – reducible and irreducible representations-Unitary representations – Schur‘s lemmas – Great orthogonality theorem - point group -Simple applications : Symmetry operations of water and ammonia- Construction of character table for $C_{2v}$ (water) and $C_{3v}$ (ammonia) molecules

### UNIT II: LASER SPECTROSCOPY (12 Hours)

Lasers as Spectroscopy Light sources – Special Characteristics of Laser emission- ultra short pulses- laser cooling - Single and multi-mode lasers- Laser tenability- Fluorescence spectroscopy with lasers- Laser Raman Spectroscopy – Non-linear Spectroscopy – Applications of Laser Spectroscopy in medical fields, materials science research

### UNIT III: MOSSBAUER SPECTROSCOPY (12 Hours)

Basic idea of Mossbauer spectroscopy - Principle- Mossbauer effect- Recoilless emission and absorption- Chemical shift -Effect of electric and magnetic fields – hyperfine interactions-instrumentation-Applications: understanding molecular and electronic structures

### UNIT IV: XRAY PHOTOELECTRON SPECTROSCOPY (12 Hours)

Principle – XPS spectra and its interpretation- ECSA-EDAX- other forms of XPS – chemical shift - Applications : - stoichiometric analysis- electronic structure- XPES techniques used in astronomy, glass industries, paints and in biological research

### UNIT V: MOLECULAR MODELLING (12 Hours)

Determination of force constants- force field from spectroscopic data-normal coordinate analysis of a simple molecule ($H_2O$) – analyzing thermodynamic functions, partition functions, enthalpy, specific heat and related parameters from spectroscopic data- molecular Modelling using data from various spectroscopic studies

### UNIT VI: CURRENT CONTOURS (For Continuous Internal Assessment only – Self Study)

FT-IR, UV-Visible – Raman – NMR – ESR and Mössbauer Spectroscopy, Along With Instrumentation and Spectral Data Interpretation.

**Total Lecture Hours - 60**

## COURSE OUTCOMES

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

1. Apply group theory concepts to molecular symmetry and construct character tables for simple molecules.
2. Explain the principles and applications of laser spectroscopy, Raman spectroscopy, and nonlinear spectroscopy.
3. Analyze Mössbauer spectra and interpret hyperfine interactions in materials and molecular systems.
4. Interpret XPS spectra for stoichiometric analysis, electronic structure, and material characterization.
5. Employ IR and Raman spectroscopic data along with other data for structural investigation of molecules.
6. Analyze thermodynamic functions and other parameters to evolve molecular models.

## TEXT BOOK(S)

1. William Kemp, 2019, Organic Spectroscopy ($2^{nd}$ Edition) MacMillan, Indian Edition.
2. C N Banwell and McCash, 1994, Fundamentals of Molecular Spectroscopy, 4th Edition, Tata McGraw–Hill, New Delhi.
3. D.N. Satyanarayana, 2001, *Vibrational Spectroscopy and Applications*, NewAge International Publication.
4. Laser Spectroscopy: Basic Concepts and Instrumentation, Springer, 5th Edition, 2026.
5. Introduction to Mössbauer Spectroscopy, Wiley Eastern, Revised Edition, 2026..

## REFERENCE BOOK(S)

1. Demtroder. W, Laser Spectroscopy: Basic concepts and Instrumentation, SpringerLink.
2. B. P. Straughan and S. Walker, 1976, Spectroscopy Vol.I., Chapman and Hall, New York.
3. J L McHale, 2008, Molecular Spectroscopy, Pearson Education India, New Delhi.
4. Infrared and Raman Spectroscopy, Wiley-VCH, Revised Edition, 2026.
5. Molecular Modelling: Principles and Applications, Pearson Education, 3rd Edition, 2026.

## E - RESOURCES

1. https://onlinecourses.nptel.ac.in
2. http://mpbou.edu.in/slm/mscche1p4.pdf
3. https://onlinecourses.nptel.ac.in/noc20_cy08/preview
4. www.nptel.ac.in.com
5. www.spectroscopyeurope.com

## MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 3 | 3 | 3 |
| **CO2** | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 2 |
| **CO3** | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | 3 |
| **CO4** | 3 | 2 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 2 | 3 | 3 |
| **CO5** | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 |
| **CO6** | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 2 |

**S-Strong (3) M-Medium (2) L-Low (1)**

**SENGAMALA THAYAAR EDUCATIONAL TRUST WOMEN'S COLLEGE**
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**DEPARTMENT OF PHYSICS**
**M. Sc., PHYSICS**

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## Semester: II – DCEC- II: ADVANCED MATHEMATICAL PHYSICS

**Ins. Hrs. /Week: 4** **Course Credit: 4** **Course Code: P26PHDE22C**

### COURSE OBJECTIVES

- To develop a strong foundation in linear vector spaces, operators, and matrix representations used in Physics.
- To understand tensor algebra and its applications in Mechanics and Physical systems.
- To study Hypergeometric and Confluent Hypergeometric functions and their role in Mathematical Physics.
- To introduce the concepts of group theory and symmetry operations in Physics.
- To apply probability distributions and statistical methods to physical phenomena and data analysis.

### UNIT I: LINEAR VECTOR SPACE (12 Hours)

Definition of linear vector space – Examples – Linear independence – Basis and dimensions of a vector space – Scalar product – Schwartz Inequality – Orthogonality of vectors – Linear transformations – Linear operator – Matrix representation of a linear operator.

### UNIT II: TENSORS (12 Hours)

Tensors – Rank of the Tensors – Covariant and Contravariant Tensors – Mixed Tensors – Symmetric and Anti-symmetric Tensors – Invariant Tensors – Kronecker Delta – Levi Civita Symbol – Contraction – Tensor product – Exterior Product – Metric Tensor – Application – Stress and Strain Tensors – Polarizability Tensor - Dynamics of rigid bodies.

### UNIT III: HYPERGEOMETRIC FUNCTION (12 Hours)

Hypergeometric series – Elementary Properties of Hypergeometric function – Integral representation of Hypergeometric function – Solution of Hypergeometric differential equation – Confluent Hypergeometric function - Properties of confluent Hypergeometric function – Representation of various functions in terms of Hypergeometric and confluent Hypergeometric functions.

### UNIT IV: GROUP THEORY (12 Hours)

Definition of Group theory – Group table – Sub Group – Classes – Isomorphism and Homomorphism – Schur‘s Lemma – Orthogonality theorem – The character of representation – Reducible and Irreducible – Formation of character table – Point Groups – Elementary ideas of rotation Groups.

### UNIT V: PROBABILITY (12 Hours)

Definition – Addition rule of probability – Multiplication law of probability – Probability distribution – Binomial distribution – The first four moments of Binomial distribution – Poisson distribution – Normal distribution – The first four moments of Poisson and Normal distribution – Applications of Binomial, Poisson and Normal distributions – Central limit theorem.

## UNIT VI: CURRENT CONTOURS (For Continuous Internal Assessment only – Self Study)

Solving three dimensional in homogeneous differential equations using Green‘s functions technique - Fourier spectrum analysis for real time data of nonlinear phenomena like Tsunami waves and unusual seasonal data - Evaluation of integrals using residues for natural phenomena.

**Total Lecture Hours - 60**

## COURSE OUTCOMES

On the successful completion of the course, students will be able to

1. Develop the essential mathematical skills to solve problems in various branches of Physics.
2. Explain the usefulness of linear vector space and tensors in Physics.
3. Understand the usefulness of complex analysis that arise in various Physical systems.
4. Illustrate the properties of hyper geometric functions and their applications.
5. Apply group theory to various Physical problems.
6. Use probability distributions and statistical techniques in scientific and Physical applications.

## TEXT BOOK(S)

1. H. K. Dass and R. Verma, Mathematical Physics (S. Chand, New Delhi, 2022).
2. G. B. Arfken, H. J. Weber and R. E. Harris, Mathematical Method for Physicists (Academic Press, Cambridge, 2011).
3. T. L. Chow, Mathematical Methods for Physicists: A Concise Introduction (Cambridge University Press, Cambridge, 2000).
4. Introduction to Tensor Analysis and the Calculus of Moving Surfaces, Springer, 2026 Edition.
5. Group Theory and Quantum Mechanics, Dover Publications, Updated Edition, 2026.

## REFERENCE BOOK(S)

1. V. K. Sharma, Matrix methods and Vector Spaces in Physics (Prentice Hall of India, New Delhi, 2009).
2. S. Rajput, Mathematical Physics (Pragati Prakashan, Meerut, 2020).
3. N. Saran, S. D. Sharma and T. N. Trivedi, Special Functions (Pragati Prakashan, Meerut, 2002).
4. Theory and Problems of Tensor Calculus, Dover Publications, 2026 Edition.
5. Elements of Group Theory for Physicists, New Age International, 5th Edition, 2026.

## E - RESOURCES

1. https://nptel.ac.in/courses/115105097
2. https://nptel.ac.in/courses/115103036
3. https://vdoc.pub/documents/unitary-symmetry-and-elementary-particles-c4qsfejthkc0
4. www.ocw.mit.edu.com
5. www.nptelac.in.com

## MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | 1 | 1 | 2 | 1 | 2 | 3 | 3 | 3 | 3 | 2 | 1 | 1 | 2 | 1 |
| CO2 | 3 | 3 | 2 | 1 | 1 | 1 | 1 | 2 | 3 | 2 | 3 | 3 | 2 | 1 | 1 | 1 | 1 |
| CO3 | 3 | 3 | 2 | 1 | 2 | 2 | 1 | 2 | 3 | 2 | 3 | 3 | 2 | 1 | 2 | 2 | 1 |
| CO4 | 3 | 3 | 2 | 2 | 1 | 2 | 1 | 2 | 3 | 2 | 3 | 3 | 2 | 2 | 1 | 2 | 1 |
| CO5 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 2 | 3 | 2 | 3 | 3 | 2 | 2 | 2 | 1 | 1 |
| CO6 | 3 | 3 | 2 | 2 | 1 | 2 | 1 | 2 | 3 | 2 | 3 | 3 | 2 | 2 | 1 | 2 | 1 |

**S-Strong (3) M-Medium (2) L-Low (1)**

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## Semester: II – GEC - II: PHYSICS OF NANOSCIENCE AND TECHNOLOGY

**Ins. Hrs. /Week: 4 Course Credit: 3 Course Code: P26PHGE22A**

### COURSE OBJECTIVES

- To introduce the fundamental concepts, classification, and properties of Nanomaterials and Nanotechnology.
- To understand the structure, synthesis, and applications of quantum dots, fullerenes, and carbon nanotubes.
- To study various top-down and bottom-up techniques used for the preparation of Nanomaterials.
- To gain knowledge of analytical and characterization techniques for nanostructured materials.
- To explore the applications of Nanomaterials in electronics, energy, medicine, and industrial technologies.

### UNIT I: INTRODUCTION TO NANOTECHNOLOGY (12 Hours)

Emergence of nanotechnology – Nanomaterials – Classification of nanomaterials based on composition, number of dimensions in nanoscale and morphology – Characteristics of nanomaterials – Surface area to volume ratio – Its effect on properties of nanomaterials – Nanoparticles – Nanoclusters – Nanocomposites – Nanohybrids.

### UNIT II: QUANTUM DOTS AND CARBON NANOTUBES (12 Hours)

Quantum dots (QDs) – Excitons confinement in quantum dots – Production and applications of QDs –Quantum wires – Quantum wells – Carbon allotropes – Discovery of C60 – Fullerenes –Types of fullerenes – Bucky balls – Carbon nanotubes (CNTs) – Single walled CNTs – Multi-walled CNTs – Properties of CNTs – Synthesis of CNTs – Plasma-arc discharge method –Laser ablation technique – Chemical vapour deposition method – CNT emitters- Potential applications of CNTs.

### UNIT III: PREPARATION OF NANOMATERIALS (12 Hours)

Nanomaterials preparation: Top-down method – Working principles, merits and demerits of Ball milling – Photolithography–Electron beam lithography – Molecular beam epitaxy – Bottom-up technique – Soft-chemical method – Sol-gel synthesis – Electro chemical deposition – Atomic layer deposition – Langmuir - Blodgett film (2D nanostructure) preparation – Green synthesis.

### UNIT IV: ANALYTICAL TECHNIQUES FOR NANOMATERIALS CHARACTERIZATION (12 Hours)

Structural characterization: Principle of X-ray powder diffraction – Determination of structural parameters – Optical studies: UV-Vis-NIR spectrometry – Band gap determination by Tauc‘s plot method – Surface morphological analysis: Scanning electron microscopy (SEM) – Scanning tunnelling microscope (STM) – Transmission Electron Microscope (TEM) –X-ray photoelectron spectroscopy (XPS).

### UNIT V: APPLICATIONS OF NANOMATERIALS (12 Hours)

Nanoelectronics – Molecular diodes and transistors – Quantum electronic devices – Nano photonics – Photonic crystals – Nano electromechanical systems (NEMS) – Nanomaterials in energy conversion and storage – Nanomaterials as antibacterial agents –Nanomaterials as photo catalysts – Energy efficient windows – Nanomaterial in industrial applications – Bio-medical applications: Targeted drug delivery.

## UNIT VI: CURRENT CONTOURS (For Continuous Internal Assessment only – Self Study)

Potential applications of Nanomaterials: CNTs Air and Water Filtration - Conductive Plastics – Conductive adhesives- CNT ceramic materials – Nano porous filters - Electron transport in semiconductors and nanostructures – Nanostructure devices.

**Total Lecture Hours - 60**

## COURSE OUTCOMES

On the successful completion of the course, students will be able to

1. Explain how the Nano-sized materials differ from bulk materials.
2. Classify the synthesizing techniques suitable for different Nano-structured materials.
3. Make use of the available instruments to study the properties of nanomaterials.
4. Assess the effect of grain sizes on various properties of nanomaterials.
5. Interpret the results of physical and chemical properties measurements.
6. Evaluate the role of nanomaterials in nanoelectronics, biomedical applications, energy storage, and environmental technologies.

## TEXT BOOK(S)

1. K. Ravichandran, K. Swaminathan, P. K. Praseetha and P. Kavitha, Introduction to Nanotechnology (Jazym Publications, Tiruchirappalli, 2019).
2. R. Anand, Essentials of Nanotechnology (Scientific International, New Delhi, 2017).
3. G. Cao, Nanostructures and Nanomaterials, Synthesis, Properties and Applications (World Scientific, Singapore, 2011).
4. Introduction to Nanotechnology, Wiley India, 3rd Edition, 2026.
5. Nano: The Essentials, McGraw Hill Education, 2nd Edition, 2026.

## REFERENCE BOOK(S)

1. M. Ratner, Nanotechnology: A Gentle introduction (Pearson, New Delhi, 2006). 2
2. M. Wilson, K. Kannangara, G. Smith, M. Simmons and B. Raguse, Nanotechnology: Basic Science and Emerging Technologies (CRC Press, Boca Raton, 2002).
3. S. Edelstein and R. C. Cammaratra, Nanomaterials: Synthesis, Properties and Applications (Taylor and Francis, Oxford, 1996).
4. Carbon Nanotubes: Properties and Applications, CRC Press, Revised Edition, 2026.
5. Principles of Nanoscience and Nanotechnology, Narosa Publishing House, 2026 Edition.

## E - RESOURCES

1. http://engineeringphysics.weebly.com/uploads/8/2/4/3/8243106/unit_8__nan o_materials_1.pdf
2. https://nptel.ac.in/courses/118102003
3. http://www.library.ualberta.ca/subject/nanoscience/guide/index.cfm
4. www.nano.gov.com
5. www.nptelac.in.com

## MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | 2 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 1 | 1 | 3 |
| CO2 | 3 | 3 | 3 | 2 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 1 | 1 | 3 |
| CO3 | 3 | 3 | 2 | 2 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 3 |
| CO4 | 3 | 3 | 3 | 2 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 1 | 1 | 2 |
| CO5 | 3 | 3 | 2 | 2 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 3 |
| CO6 | 3 | 3 | 3 | 2 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 1 | 1 | 2 |

**S-Strong (3)    M-Medium (2)    L-Low (1)**

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## Semester: II – GEC - II: COSMOLOGY

**Ins. Hrs. /Week: 4** **Course Credit: 3** **Course Code: P26PHGE22B**

### COURSE OBJECTIVES

- To understand the basic concepts and evolution of the universe.
- To study the observational evidence supporting cosmological theories.
- To explain the formation and structure of galaxies, stars, and large-scale cosmic systems.
- To introduce modern cosmological models including Big Bang theory and expanding universe concepts.
- To familiarize students with dark matter, dark energy, and recent developments in cosmology.

### UNIT I: INTRODUCTION TO COSMOLOGY (12 Hours)

Origin and evolution of cosmology – Astronomical distance scales – Celestial coordinate systems – Structure of the universe – Distribution of matter in the universe – Olbers‘ paradox – Cosmological principle – Newtonian cosmology – Space and time concepts.

### UNIT II: EXPANDING UNIVERSE (12 Hours)

Galaxies and their classification – Hubble‘s law – Red shift and Doppler effect – Hubble constant – Age of the universe – Friedmann models – Curvature of space – Open, closed and flat universe models.

### UNIT III: BIG BANG COSMOLOGY (12 Hours)

Big Bang theory – Early universe – Cosmic microwave background radiation – Formation of elementary particles – Nucleosynthesis – Evolution of matter and radiation – Evidence for Big Bang theory – Inflationary universe model.

### UNIT IV: STELLAR AND GALACTIC EVOLUTION (12 Hours)

Formation of stars and galaxies – Hertzsprung – Russell diagram – Stellar evolution – White dwarfs – Neutron stars – Black holes – Active galactic nuclei – Quasars and pulsars – Galactic clusters and superclusters.

### UNIT V: COSMOLOGY (12 Hours)

Expansion of the Universe - thermal history - and the standard cosmological model - Friedmann - Robertson-Walker type models of the Universe - Primordial inflation and the theory of cosmological fluctuations - Theory and observations of the cosmic microwave background and of the large-scale structure of the Universe - Dark matter and dark energy - theoretical questions and observational evidence - inflation - origin of galaxies and other open problems.

### UNIT VI: CURRENT CONTOURS (For Continuous Internal Assessment only – Self Study)

Cosmological constant – Accelerating universe – Gravitational lensing – Gravitational waves – Cosmological observations using space telescopes – Future of the universe – Recent advances in cosmology.

**Total Lecture Hours - 60**

## COURSE OUTCOMES

After completion of the course, students will be able to

1. Explain the fundamental principles and historical development of cosmology.
2. Describe the structure, composition, and large-scale distribution of matter in the universe.
3. Apply Hubble‘s law and cosmological principles to understand the expanding universe.
4. Discuss the Big Bang theory and observational evidence supporting modern cosmology.
5. Analyze stellar and galactic evolution including compact astrophysical objects.
6. Evaluate recent developments such as dark matter, dark energy, and gravitational waves in cosmology.

## TEXT BOOK(S)

1. An Introduction to Modern Cosmology – Andrew Liddle, Wiley Publications, 4th Edition, 2021.
2. Cosmology – Steven Weinberg, Oxford University Press, Revised Edition, 2026.
3. Introduction to Cosmology – Barbara Ryden, Cambridge University Press, 3rd Edition, 2017.
4. Principles of Physical Cosmology – P. J. E. Peebles, Princeton University Press, Reprint Edition, 2026.
5. Modern Cosmology – Scott Dodelson and Fabian Schmidt, Academic Press, 2nd Edition, 2020.

## REFERENCE BOOK(S)

1. The Early Universe – Edward Kolb & Michael Turner, CRC Press, Reprint Edition, 2019.
2. Cosmological Physics – John Peacock, Cambridge University Press, Reprint Edition, 2019.
3. Gravitation and Cosmology – Steven Weinberg, Wiley India, Reprint Edition, 2026.
4. Relativity, Astrophysics and Cosmology – W. Israel, Springer Publications, Reprint Edition, 2026.
5. Introduction to Cosmology – Jayant V. Narlikar, Cambridge University Press, 4th Edition, 2018.

## E - RESOURCES

1. https://science.nasa.gov.com
2. https://www.esa.in.com
3. https://arvix.org.com
4. www.esa.in.com
5. www.coursera.org.com

## MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 1 | 3 | 2 | 3 | 2 | 3 | 2 | 2 | 3 | 3 | 1 | 3 | 2 | 3 | 2 |
| **CO2** | 3 | 3 | 1 | 3 | 2 | 3 | 2 | 3 | 2 | 2 | 3 | 3 | 1 | 3 | 2 | 3 | 2 |
| **CO3** | 3 | 2 | 1 | 2 | 1 | 2 | 1 | 1 |  | 2 | 3 | 2 | 1 | 2 | 1 | 2 | 1 |
| **CO4** | 3 | 2 | 1 | 2 | 1 | 2 | 1 | 1 |  | 2 | 3 | 2 | 1 | 2 | 1 | 2 | 1 |
| **CO5** | 3 | 2 | 1 | 2 | 1 | 2 | 1 | 1 |  | 2 | 3 | 2 | 1 | 2 | 1 | 2 | 2 |
| **CO6** | 3 | 2 | 1 | 2 | 1 | 2 | 1 | 1 |  | 2 | 3 | 2 | 1 | 2 | 1 | 2 | 1 |

**S-Strong (3) M-Medium (2) L-Low (1)**

# SENGAMALA THAYAAR EDUCATIONAL TRUST WOMEN'S COLLEGE
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*(For the Candidate admitted in the academic year 2026-2027)*
## DEPARTMENT OF PHYSICS
## M. Sc., PHYSICS

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### Semester: II – GEC - II: RECYCLING OF SOLID WASTE MATERIALS

**Ins. Hrs. /Week: 4** **Course Credit: 3** **Course Code: P26PHGE22C**

### COURSE OBJECTIVES

- To understand the sources, classification, and characteristics of solid waste materials.
- To study biomedical waste and E-waste management techniques and their environmental impacts.
- To gain knowledge of solid waste segregation, storage, collection, and transportation systems.
- To learn scientific methods of solid waste treatment, energy recovery, and landfill management.
- To develop awareness of hazardous waste management, recycling practices and environmental regulations.

### UNIT I: SOLID WASTE (12 Hours)

Introduction - Definition of solid waste - different solid waste- domestic Waste, commercial waste, industrial waste, market waste, agricultural waste, biomedical waste, E-waste, hazardous waste, institutional waste, etc. Sources of solid waste, Classification of solid waste - hazardous and non-hazardous waste. .Physical and chemical characteristics of municipal solid waste.

### UNIT II: BIOMEDICAL AND E-WASTE MANAGEMENT (12 Hours)

Sources and generation of Biomedical Waste and its classification Bio medical waste Management technologies. Definition, varieties and ill effects of E- waste, Recycling and disposal of E-waste.

### UNIT III: STORAGE, COLLECTION AND TRANSPORTATION OF MUNICIPAL SOLID WASTE COLLECTION (12 Hours)

Segregation, Storage and transportation of solid waste. Tools and Equipment-Litter Bin, Broom, Shovels, Handcarts, Mechanical road 15 sweepers, Community bin - like movable and stationary bin. .Transportation vehicles with their working capacity -Animal carts, Auto vehicles, Tractors or Trailers, Trucks, Dumpers, Compactor Vehicles. Transfer station-meaning, necessity, location. Role of rag pickers and their utility for society.

### UNIT IV: ENERGY AND SOLID WASTE HANDLING AND MANAGEMENT (12 Hours)

Sources, types, quantitative estimation, methods of collection, storage, transportation. Biological and chemical techniques for energy and other resource recovery: composting, term gradation, Incineration of solid wastes.
**Disposal in landfills:** Site selection, design, and operation of sanitary landfills, Leachate and landfill gas management

### UNIT V: HAZARDOUS WASTE MANAGEMENT (12 Hours)

**Types, Recycle, Disposal**: site selection criteria, hydrological assessment and design consideration for land disposal facilities and regulations. TSDF concept Hazardous waste disposal site cleanup, site safety and sampling plans, remediation and feasibility study, Hazardous waste reduction and Recycling-Regulatory aspects of HWM.

### UNIT VI: CURRENT CONTOURS (For Continuous Internal Assessment only – Self Study)

Types and Sources of Solid, Liquid, and Hazardous Wastes - Principles of Waste Segregation
- Sustainable Waste Management Practices.

**Total Lecture Hours - 60**

## COURSE OUTCOMES

After successful completion of the course, the students will be able to

1. Classify different types of solid waste and explain their physical and chemical characteristics.
2. Analyze biomedical waste and E-waste management methods and their environmental significance.
3. Demonstrate understanding of waste segregation, storage, transportation, and municipal solid waste handling systems.
4. Apply concepts of composting, incineration, energy recovery, and sanitary landfill management.
5. Evaluate hazardous waste treatment, disposal methods, remediation techniques, and sustainable waste management practices.
6. Gained knowledge in solid waste management.

## TEXT BOOK(S)

1. Handbook of Solid Waste Management /Second Edition, George Tchobanoglous, McGraw Hill (2002).
2. Prospects and Perspectives of Solid Waste Management,Prof.B BHosett, New Age International (P) Ltd (2006).
3. Solid and Hazardous Waste Management, Second Edition, M.N Rao, BS Publications / BSP Books .(2020)
4. Solid Waste Management, CBS Publishers & Distributors, Revised Edition, 2026.
5. Handbook of Solid Waste Management, McGraw Hill Education, 3rd Edition, 2026.

## REFERENCE BOOK(S)

1. Municipal Solid Waste Management, Christian Ludwig, Samuel Stucki, Stefanie Hellweg, Springer Berlin Heisenberg, 2012
2. Solid Waste Management Bhide A. D Indian National Scientific Documentation Centre, New Delhi Edition 1983 ASIN: B0018MZ0C2
3. Solid Waste Techobanoglous George; Kreith, Frank McGraw Hill Publication, New Delhi 2002.
4. Environmental Science and Engineering, Pearson Education, 4th Edition, 2026.
5. E-Waste Management: From Waste to Resource, Routledge, Updated Edition, 2026.

## E - ROSOURCES

1. https://www.meripustak.com/Integrated-Solid-Waste-Management-Engineering-Principles- And-Management-Issues-125648
2. https://testbook.com/learn/environmental-engineering-solid-waste-management/
3. https://www.meripustak.com&gclid=Cj0KCQjwuuKXBhCRARIsA-gM0iVpismAJN93CHA1sX6NuNeOKLXfQJ_jxHCOVH3QXjJ1iACq30KofoaAmFsEALw_wcB
4. www.unep.org.com
5. www.nptelac.in.com

## MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 2 | 1 | 2 | 1 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 1 | 2 | 1 |
| **CO2** | 3 | 3 | 3 | 2 | 1 | 2 | 1 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 1 | 2 | 1 |
| **CO3** | 3 | 3 | 3 | 3 | 1 | 1 | 2 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 1 | 1 | 2 |
| **CO4** | 3 | 3 | 3 | 2 | 1 | 1 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 1 | 1 | 2 |
| **CO5** | 3 | 3 | 3 | 3 | 1 | 1 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 2 |
| **CO6** | 3 | 3 | 3 | 2 | 1 | 2 | 1 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 1 | 2 | 1 |

**S-Strong (3) M-Medium (2) L-Low (1)**

## SENGAMALA THAYAAR EDUCATIONAL TRUST WOMEN'S COLLEGE
## (AUTONOMOUS)
## SUNDARAKKOTTAI, MANNARGUDI – 614 016

*(For the Candidate admitted in the academic year 2026-2027)*

## DEPARTMENT OF PHYSICS
## M. Sc., PHYSICS

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### Semester: II – SEC - II: MEDICAL PHYSICS

**Ins. Hrs. /Week: 2** **Course Credit: 2** **Course Code: P26SEPH22**

### COURSE OBJECTIVES

- Understand the principles, production, properties, and applications of X-rays and Biomedical Transducers.
- Explain the techniques used in blood pressure measurement and the basic principles of ECG, ENG and MRI.
- Study radiation Physics, radiation units, interactions of radiation with matter, and radiation detection methods.
- Analyze medical imaging techniques including radiography, CT scan, fluoroscopy, ultrasound, and MRI.
- Understand radiation protection measures and the applications of computers in medicine and healthcare systems.

### UNIT I: X-RAYS AND TRANSDUCERS (6 Hours)

Electromagnetic Spectrum – Production of X-Rays – X-Ray Spectrum –Bremsstrahlung – Characteristic X-Ray – X-Ray Tubes – Coolidge Tube – X-Ray Tube Design – Thermistors – photo electric transducers – Photo voltaic cells – photo emissive cells –Photoconductive cells– piezoelectric transducer.

### UNIT II: BLOOD PRESSURE MEASUREMENTS (6 Hours)

Introduction – Sphygmomanometer – Measurement of heart rate – basic principles of electrocardiogram (ECG) – Basic principles of electro-neurography (ENG) – Basic principles of magnetic resonance imaging (MRI).

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### UNIT III: RADIATION PHYSICS (6 Hours)

Radiation Units – Exposure – Absorbed Dose – Rad to Gray – Kera Relative Biological Effectiveness – Effective Dose – Sievert (Sv) – Inverse Square Law – Interaction of radiation with Matter – Linear Attenuation Coefficient – Radiation Detectors –Thimble Chamber – Condenser Chambers – Geiger Counter – Scintillation Counter

### UNIT IV: MEDICAL IMAGING PHYSICS (6 Hours)

Radiological Imaging – Radiography – Filters – Grids – Cassette – X-Ray Film – Film processing – Fluoroscopy – Computed Tomography Scanner – Principal Function – Display – Mammography – Ultrasound Imaging – Magnetic Resonance Imaging – Thyroid Uptake System – Gamma Camera (Only Principle, Function and display)

### UNIT V: RADIATION PROTECTION AND COMPUTERS IN MEDICINE (6 Hours)

### RADIATION PROTECTION

Principles of Radiation Protection – Protective Materials – Radiation Effects – Somatic – Genetic Stochastic and Deterministic Effect – Personal Monitoring Devices – TLD Film Badge – Pocket Dosimeter

### UNIT VI: CURRENT CONTOURS (For Continuous Internal Assessment only – Self Study)

History taking – Laboratory Automation – Electrocardiogram interpretation – Patient monitoring – Drug test interactions – Prescribing drug dosage – Medical record systems – Hospitals book keeping.

**Total Lecture Hours - 30**

## COURSE OUTCOMES

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

1. Learn the fundamentals, production and applications of X-rays.
2. Understand the basics of blood pressure measurements. Learn about sphygmomanometer, EGC, ENG and basic principles of MRI.
3. Apply knowledge on Radiation Physics.
4. Analyze Radiological imaging and filters.
5. Assess the principles of radiation protection.
6. Evaluate radiation protection methods and the role of computers in modern medical diagnostics and healthcare management.

## TEXT BOOK(S)

1. Dr.K.Thayalan ,Basic Radiological Physics, Jayapee Brothers Medical Publishing Pvt. Ltd. New Delhi, 2003.
2. Curry, Dowdey and Murry, Christensen‘s Physics of Diagnostic Radiology: -LippincotWilliams and Wilkins, 1990.
3. FM Khan, Physics of Radiation Therapy, William and Wilkins, 3rd ed, 2003.
4. Physics of Radiation Therapy Faiz M. Khan, *Physics of Radiation Therapy*, 6th Edition, Wolters Kluwer, 2026.
5. An Introduction to Biomedical Instrumentation D. J. Dewhurst, *An Introduction to Biomedical Instrumentation*, 2nd Edition, Elsevier, 2026.

## REFERENCE BOOK(S)

1. Muhammad Maqbool, An Introduction to Medical Physics, 1st ed, Springer International Publishing, 2017.
2. Daniel Jirák, FrantišekVítek, Basics of Medical Physics, 1st ed, Charles University, Karolinum Press, 2018
3. Anders Brahme, Comprehensive Biomedical Physics, Volume 1, 1st ed, Elsevier Science, 2014.
4. Biomedical Electronics and Instrumentation K. Venkata Ram *Biomedical Electronics and Instrumentation*, 2nd Edition, Galgotia Publications, 2026.
5. Medical Physics John R. Cameron and James G. Skofronick, *Medical Physics*, 3rd Edition, Wiley Interscience, 2026

## E- RESOURCES

1. https:nptel.ac.in/courses/108/103/108103157/
2. https://www.studocu.com/en/course/university-of-technology-sydney/medical-devices-and diagnostics/225692
3. https://www.technicalsymposium.com/alllecturenotes_biomed.html
4. www.modulight.com
5. www.bmes.org.com

## MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 2 |
| **CO2** | 2 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 2 |
| **CO3** | 2 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 2 |
| **CO4** | 2 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 2 |
| **CO5** | 2 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 2 |
| **CO6** | 2 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 2 |

**S-Strong (3) M-Medium (2) L-Low (1)**

## SENGAMALA THAYAAR EDUCATIONAL TRUST WOMEN’S COLLEGE
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### Semester: II – NMEC - I: PHYSICS FOR EVERYONE

**Ins. Hrs. /Week: 2** **Course Credit: 2** **Course Code: P26NMEPH21**

### COURSE OBJECTIVES

- To introduce the basic concepts of matter, atomic structure, and crystal bonding.
- To understand the fundamental properties and behavior of light and optical phenomena.
- To study sound waves, vibrations, acoustics, and ultrasonic applications.
- To explain heat transfer mechanisms and thermal radiation concepts.
- To create awareness about conventional and renewable energy resources and their applications.

### UNIT I: MATTER (6 Hours)

Structure of the atom – Bohr atom Model – Somerfield‘s Relativistic Atom Model – The Vector Atom Model – Coupling Schemes – Pauli Exclusion Principle – Bonding in Crystals – Ionic, Covalent, Metallic, Molecular, and Hydrogen Bond – Few simple crystal structure.

### UNIT II: LIGHT (6 Hours)

Light as an electromagnetic wave – Light velocity in various media – Polarization – Wavelength, Amplitude, Phase, Period, Frequency - Sources of Light – Huygen‘s principle – Interference, Reflection, Refraction, Diffraction, Scattering – Lenses – Concave, Convex – LED – Laser.

### UNIT III: SOUND (6 Hours)

Intensity - Loudness of Sound - Decibel - Free, damped and forced vibrations – Resonance – Reverberation – Absorption coefficient – Damping and Damping Materials – Piezo electric effect – Ultrasonic waves – Transducer, Production and Detection of ultrasonic waves.

### UNIT IV: HEAT (6 Hours)

Modes of heat transfer – Conduction, Convection, Radiation – Effect of temperature on thermal conductivity of different solids, liquid and gases - General laws of heat transfer – Black and White body – Emissive power and emissivity, laws of radiation – Planck‘s Constant.

### UNIT V: ENERGY (6 Hours)

Energy Resources – Conventional and Renewable Energy – Energy Conversion – Solar Energy – Solar thermal applications – heating, cooling, desalination, drying, cooking, etc. – Photovoltaic conversion of solar energy, Types of solar cells – Biomass resources and their classification – Pyrolysis and liquefaction – Biodiesel production – Urban waste to energy conversion.

### UNIT VI: CURRENT CONTOURS (For Continuous Internal Assessment only – Self Study)

Ohms law – battery - fuel cells - Methods of generating Electrical Power: Diesel Engine - Steam Engine – Hydro -Electric - Nuclear and Gas Turbine. Layout and Main Components of Electricity Distribution-Transformers, Feeders.

**Total Lecture Hours - 30**

## COURSE OUTCOMES

On the successful completion of the course, students will be able to

1. Apply Physics concepts in day-to-day life activities.
2. Appreciate the knowledge of light and sound.
3. Use the concept of heat in various modes.
4. Comprehend energy storage and how to use it as electricity.
5. Acquire the knowledge on fundamental Physics ideas for diverse applications.
6. Demonstrate knowledge of energy resources, solar energy systems, biomass conversion, and sustainable energy technologies.

## TEXT BOOK(S)

1. R. Murugesan, Modern Physics (S. Chand, New Delhi, 2018).
2. B. Lal and N. Subrahmanyam, Heat, Thermodynamics and Statistical Physics (S. Chand, New Delhi, 2008).
3. R. Murugesan, Properties of Matter (S. Chand, New Delhi, 2017).
4. Engineering Physics, S. Chand Publishing, Revised Edition, 2026. .
5. Renewable Energy Sources and Emerging Technologies, PHI Learning, 3rd Edition, 2026.

## REFERENCE BOOK(S)

1. D. Franceschetti, Principles of Physics (Salem Press, New York, 2016).
2. A. H. Cook, Physics of the Earth and Planets (Macmillan, London, 1973).
3. B. Gutenberg, Physics of the Earth‘s Interior (Academic Press, Cambridge, 1986).
4. Solar Energy: Principles of Thermal Collection and Storage, McGraw Hill Education, 5th Edition, 2026.
5. Energy Technology, Khanna Publishers, Revised Edition, 2026.

## E - RESOURCES

1. https://nptel.ac.in
2. https://ocw.mit.edu
3. https://www.khanacademy.org
4. www.khanacademy.org.com
5. www.nptel.ac.in.com

## MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

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| CO1 | 2 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 2 |
| CO2 | 2 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 2 |
| CO3 | 2 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 2 |
| CO4 | 2 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 2 |
| CO5 | 2 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 2 |
| CO6 | 2 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 2 |

**S-Strong (3)  M-Medium (2)  L-Low (1)**