Annamalai University

(Accredited with 'A' Grade by NAAC)

Faculty of Science

DEPARTMENT OF PHYSICS

(DST - FIST Supported)

M.Sc. PHYSICS

Programme Code : SPHY21

Regulations, Curricula and Syllabi

(2020 - 2021)

Annamalai University

Faculty of Science

DEPARTMENT OF PHYSICS

M.Sc. PHYSICS [Two Year]

Programme Code : SPHY21

These rules and regulations shall govern the Two year post graduate studies leading to the award of degree of **Master of Science in Physics** in the Faculty of Science. These academic Regulations shall be called **Annamalai University, Faculty of Science M.Sc. Physics (Two Year) Regulations 2020**. They shall come into force with effect from the academic year 2020 - 2021.

1. **Definitions and Nomenclature**

1.1 **University** refers to Annamalai University.

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

1.3 **Discipline** refers to the specialization or branch of knowledge taught and researched in higher education. For example, Physics is a discipline in the Physical Sciences.

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

1.5 **Course** is an individual subject in a programme. Each course may consist of Lectures/Laboratory/Seminar/Project/Viva-Voce, etc. Each course has a course title and is identified by a course code.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

1.21 **Cumulative Grade Point Average** (CGPA) is a measure of overall cumulative performance of a student over all the semesters. The CGPA is the ratio of total credit points secured by a student in various courses in all the semesters and the sum of the total credits of all courses in all semesters is given in section 11.4.

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

2. Programme Offered and Eligibility Criteria

The Department of Physics offers a M.Sc. Physics (Two Year) programme. A pass in Bachelor's Degree with Physics as major subject and Mathematics and Chemistry as two allied subjects from any University with not less than 50% of marks in Part-III.

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

3. **Reservation Policy:** Admission to the various programmes will be strictly based on the reservation policy of the Government of Tamil Nadu.

4. Programme Duration

4.1 The M.Sc. Programme consists of two academic years.

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

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

5. Programme Structure

5.1 The M.Sc. Programme consists of Core Courses, Elective Courses (Departmental & Interdepartmental) and Project.

5.2 Core courses

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

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

5.3 Elective courses

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

5.3.2 Interdepartmental Electives (IDEs) are Electives that students can choose from amongst the courses offered by other departments of the same faculty as well as by the departments of other faculties. IDEs are listed in the Hand Book which is available in the University website.

5.4 Experiential Learning

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

5.4.2 In-plant training/field trips/internships/laboratories visits fall under this category.

5.4.3 Experiential learning is categorized as non-credit compulsory course.

5.5 Project

5.5.1 Each student shall undertake a project and submit a dissertation as per guidelines in the final semester.

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

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

5.5.4 Students who wish to undertake project work in recognized institutions/industry shall obtain prior permission from the University. The Research Supervisor will be from the host institute.

5.6 Value added Courses (VACs)

5.6.1 Students may also opt to take Value Added Courses beyond the minimum credits required for award of the Degree. VACs are outside the normal credit paradigm.

5.6.2 These courses impart employable and life skills. VACs are listed in the Hand Book which is available in the University website.

5.6.3 Each VAC carries 2 credits with 30 hours of instruction. Classes for a VAC are conducted beyond the regular class hours and preferably in the II and III Semesters.

5.7 Online Courses

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

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

5.8 Credit Distribution: The credit distribution is organized as follows:

Courses	Credits
Core Courses	72
Elective Courses	15
Project	06
Total	**93**

5.9 Credit Assignment

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

1 Credit is defined as

1 Lecture period of one hour duration per week over a semester

1 Tutorial period of one hour duration per week over a semester

1 Practical period of one and a half hours duration per week over a semester

1 Project period of one hour duration per week over a semester

6 Attendance

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

6.2 The record shall contain details of the students attendance, marks obtained in the Continuous Internal Assessment (CIA) Tests, Assignments and Seminars. In addition, the record shall also contain the organization of lesson plan of the course teacher.

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

6.4 At the end of the semester, the record shall be placed in safe custody for any future verification.

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

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

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

7 Mentor-Mentee System

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

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

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

8 Examinations

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

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

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

8.4 Continuous Internal Assessment Tests

8.4.1 The CIA tests shall be a combination of a variety of tools such as class tests, assignments and seminars. This requires an element of openness.

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

8.4.3 The question paper will be set by the respective faculty using Bloom's Taxonomy.

8.4.4 CIA Tests will be for one/two hours duration depending on the quantum of syllabus.

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

8.4.6 For the CIA tests, the assessment will be done by the course teacher.

8.5 End Semester Examinations (ESE)

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

8.5.2 Candidates who failed in any course will be permitted to reappear in the subsequent examinations.

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

9 Evaluation

9.1 Marks Distribution

9.1.1 For each course, the theory, practical and project shall be evaluated for a maximum of 100 marks.

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

9.1.3 For the Practical courses, the CIA tests will carry 40% and the ESE 60% of the marks.

9.2 Assessment of CIA tests

9.2.1 For the CIA tests, the assessment will be done by course teacher.

9.2.2 For the theory courses, the break-up of marks shall be as follows

CIA for Theory	Marks
Test-I & Test-II	15
Seminar	5
Assignment	5
Total	25

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

CIA for Practical	Marks
Test-I	15
Test-II	15
Record/Viva-Voce	10
Total	40

9.3 Assessment of End Semester Examinations

9.3.1 Evaluation for the ESE is done by internal Examiners

9.4 **Assessment of Project/Dissertation**

9.4.1 The Project Report/Dissertation shall be submitted as per the guidelines.

9.4.2 The Project shall carry a maximum of 100 marks.

9.4.3 CIA for Project/dissertation will consist of a review of a literature survey, experimentation and attendance etc.,

9.4.4 The project report evaluation and viva-voce will be conducted by a committee constituted by Head of the department.

9.4.5 The project evaluation committee will comprise the Head of the Department, project supervisor and a senior faculty.

9.4.6 The marks shall be distributed as follows

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

9.5 Assessment of Value-Added Courses

9.5.1 Assessment of VACs consists of two CIA tests and ESE shall be conducted by the Department(s) offering VAC.

9.5.2 The grades obtained in VACs will not be included for calculating the GPA/CGPA.

9.6 Passing Minimum

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

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

10. Conferment of the Master's Degree

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

11. Marks and Grading

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

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

11.3 The GPA is calculated by the formula

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

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

G_i is the Grade Point obtained by the student for the Course i and

n is the number of Courses passed in that semester.

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

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

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

G_i is the Grade Point obtained by the student for the Course i

n is the number of Courses passed in that semester.

m is the number of semester.

11.5 Evaluation

11.5.1 **Performance of the student for each course will be rated as shown in the Table**

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

11.5.2 A ten point rating scale is used for evaluation of the performance of the student to provide overall grade for the Master's Programme.

CGPA	CLASSIFICATION OF FINAL RESULT
8.25 and above	First Class with Distinction
6.5 and above but below 8.25	First Class
5.0 and above but below 6.5	Second Class
0.0 and above but below 5.0	Re-appear

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

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

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

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

11.6.4 Candidates who obtain overall highest CGPA in all examinations in the first appearance itself are eligible for University Rank.

11.7 Course-Wise Letter Grades

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

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

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

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

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

12. Provision for Withdrawal from the End Semester Examination

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

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

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

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

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

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

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

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

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

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

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

Annamalai University

Department of Physics

M.Sc. Physics (Two Year) Programme

Programme Code : SPHY 21

Curricula and Scheme of Examination

(For students admitted from the academic year 2020 – 2021)

Course Code	Course Title	Hours/Week			C	Marks		
		L	T	P		CIA	ESE	Total
Semester - I								
19PHYC101	Core 1 : Classical and Statistical Mechanics	4	-	-	4	25	75	100
19PHYC102	Core 2 : Electronics	4	-	-	4	25	75	100
19PHYC103	Core 3 : Mathematical Physics – I	4	-	-	4	25	75	100
19PHYP104	Core 4 : Practical – I	-	-	3	6	40	60	100
	Elective 1 : Interdepartmental Elective	3	-	-	3	25	75	100
Total Credits		-	-	-	21	-	-	-
Semester - II								
19PHYC201	Core 5 : Mathematical Physics – II	4	-	-	4	25	75	100
19PHYC202	Core 6 : Quantum Mechanics – I	4	-	-	4	25	75	100
19PHYC203	Core 7 : Electromagnetic Theory	4	-	-	4	25	75	100
19PHYC204	Core 8 : Practical – II	-	-	3	6	40	60	100
	Elective 2 : Department Elective	3	-	-	3	25	75	100
	Elective 3 : Interdepartmental Elective	3	-	-	3	25	75	100
Total Credits		-	-	-	24	-	-	-
Semester – III								
19PHYC301	Core 9 : Condensed Matter Physics - I	4	-	-	4	25	75	100
19PHYC302	Core 10 : Quantum Mechanics – II	4	-	-	4	25	75	100
19PHYC303	Core 11 : Nuclear and Elementary Particle Physics	4	-	-	4	25	75	100
19PHYC304	Core 12 : Practical – III	-	-	3	6	40	60	100
	Elective 4 : Department Elective	3	-	-	3	25	75	100
	Elective 5 : Interdepartmental Elective	3	-	-	3	25	75	100
19PSCI300	Constitution of India*	2	-	-	2*	25	75	100
Total Credits		-	-	-	24	-	-	-
Semester – IV								
19PHYC401	Core 13 : Condensed Matter Physics - II	4	-	-	4	25	75	100

19PHYC402	Core 14 : Spectroscopy	4	-	-	4	25	75	100
19PHYC403	Core 15 : Physics of Nanomaterials	4	-	-	4	25	75	100
19PHYP404	Core 16 : Practical – IV	-	-	3	6	40	60	100
19PHYD405	Project (Dissertation/Viva-Voce)		-	9	6	25	75	100
Total Credits		-	-	-	24	-	-	-
Total Credits		-	-	-	**93**	-	-	-

***Non-credit compulsory course**
L: Lecture, T: Tutorial, P: Practical, C: Credits, CIA: Continuous Internal Assessment, ESE: End Semester Examination

Note:

1. Students shall opt both Department Electives (DEs) and Interdepartmental Electives (IDEs) from a range of choices available. The details of interdepartmental electives are given in the **“Handbook of Interdepartmental Electives - PG Programmes"** and listed in the University website.
2. Students shall opt any Value-Added Courses listed in the University website. The details of Value Added Courses are given in the **"Handbook of Value Added Courses**”.

DEPARTMENT ELECTIVE COURSES (DE)

S. No.	Course Code	Course Title	Hours/ week			C	Marks		
			L	T	P		CIA	ESE	Total
		Elective 2							
1.	19PHYE205	Microprocessor and Microcontroller	3	0	0	3	25	75	100
2.	19PHYE206	Physics of the Earth	3	0	0	3	25	75	100
3.	19PHYE207	Energy Physics	3	0	0	3	25	75	100
		Elective 4							
4.	19PHYE305	Instrumentation	3	0	0	3	25	75	100
5.	19PHYE306	Biomedical Instrumentation	3	0	0	3	25	75	100
6.	19PHYE307	Petrophysics	3	0	0	3	25	75	100
7.	19PHYE308	Medical Physics	3	0	0	3	25	75	100
8.	19PHYE309	Biophysics	3	0	0	3	25	75	100

ANNAMALAI UNIVERSITY

Department of Physics

[Question Paper Pattern - INTERNAL TESTS I & II (CIA)]

(Based on Revised Bloom's Taxonomy)

Programme: M.Sc. (Two Year) **Semester: All**

Course Code: **Course Name:**

Time: 2 Hrs **Max.Marks:50**

Part-A (Level-K1) **Marks: (6x2=12)**

(Answer ALL of the questions)

1. Define /Choose/ Relate……
2. What / Why / How?
3. Multiple Choices a. b. c. d.
4. Multiple Choices a. b. c. d.
5. Match the following i - a ii - b iii - c iv - d v - …..
6. Match the following i - a ii - b iii - c iv - d v - …..

Part-B (Level-K2) **Marks: (3x5=15)**

(Answer any THREE of the questions)

7. Explain…..
8. Describe…..
9. Select……
10. Compare

Part-C (Level-K3/ Level-K4) **Marks: (2x7=14)**

(Answer any TWO of the questions)

11. Apply….
12. Calculate….
13. Categorize…

Part-D (Level-K5/ Level-K6) **Marks: (1x9=9)**

(Answer any ONE of the questions)

14. Discuss….
15. Summarize….

ANNAMALAI UNIVERSITY

Department of Physics

Pattern of question paper for END semester examinations

(Based on Revised Bloom's Taxonomy)

Programme: M.Sc. (Two Year) **Year : I** **Semester: I / II**

Course Code: **Course Name:**

Time: 3 Hrs **Max.Marks:100**

Part-A (Level-K1/ Level-K2) **Marks: (10x2=20)**

(Answer ALL of the questions)

1. Define……
2. Multiple Choices a. b. c. d.
3. Multiple Choices a. b. c. d.
4. Match the following i - a ii- b iii- c iv –d v - …..
5. Match the following i - a ii- b iii- c iv –d v - …..
6. Explain…….
7. Select…..
8. Describe……
9. Classify….
10. Elucidate….

Part-B (Level-K3/ Level-K4) **Marks: (8x5=40)**

(Answer any EIGHT of the questions)

11. Prepare…..
12. Solve…..
13. Apply……
14. Show…..
15. Categorize…
16. Analyze…
17. Distinguish….
18. Infer….
19. Compare….
20. Compute

Part-C (Level-K5) **Marks: (3x10=30)**

(Answer any THREE of the questions)

21. Discuss…
22. Summarize….
23. Evaluate…..
24. Disprove….

Part-D (Level-K6) **Marks: (1x10=10)**

(Answer any ONE of the questions)

25. Design….
26. Develop…

ANNAMALAI UNIVERSITY

Department of Physics

Programme: M.Sc. (Two Year) **Year : II** **Semester: III / IV**
Course Code: **Course Name:**
Time: 3 Hrs **Max.Marks:100**

Part-A (Level-K1/ Level-K2) **Marks: (10x2=20)**
(Answer ALL of the questions)

1. Define……
2. Multiple Choices a. b. c. d.
3. Multiple Choices a. b. c. d.
4. Match the following i - a ii- b iii- c iv –d v - …..
5. Match the following i - a ii- b iii- c iv –d v - …..
6. Explain…….
7. Select…..
8. Describe…..
9. Classify….
10. Elucidate….

Part-B (Level-K3/ Level-K4) **Marks: (6x5=30)**
(Answer any SIX of the questions)

11. Apply……
12. Show…..
13. Prepare
14. Make use of….
15. Categorize…
16. Analyze…
17. Distinguish….
18. Simplify…..

Part-C (Level-K5) **Marks: (3x10=30)**
(Answer any THREE of the questions)

19. Discuss…
20. Recommend with
21. Evaluate…..
22. Justify….
23. Optimize…

Part-D (Level-K6) **Marks: (2x10=20)**
(Answer any TWO of the questions)

24. Design….
25. Formulate …
26. Modify …..

<table>
<tr><th colspan="11">M.Sc. Physics (TWO YEAR) PROGRAMME</th></tr>
<tr><th colspan="11">[End Semester Examinations]
Bloom's Taxonomy - Questions Conforming to Levels K1 to K6</th></tr>
<tr><td></td><td colspan="4">I Year (Two year PG)</td><td></td><td colspan="4">II Year (Two Year PG)</td></tr>
<tr><td></td><td>Level</td><td>Part</td><td>Questions & Marks</td><td>Total Marks</td><td></td><td>Level</td><td>Part</td><td>Questions & Marks</td><td>Total Marks</td></tr>
<tr><td></td><td>K1</td><td rowspan="2">A</td><td>5 x 2</td><td>10</td><td></td><td>K1</td><td rowspan="2">A</td><td>5 x 2</td><td>10</td></tr>
<tr><td></td><td>K2</td><td>5 x 2</td><td>10</td><td></td><td>K2</td><td>5 x 2</td><td>10</td></tr>
<tr><td></td><td>K3</td><td rowspan="2">B</td><td>4 x5</td><td>20</td><td></td><td>K3</td><td rowspan="2">B</td><td>2 x 5</td><td>10</td></tr>
<tr><td></td><td>K4</td><td>4 x5</td><td>20</td><td></td><td>K4</td><td>4 x 5</td><td>20</td></tr>
<tr><td></td><td>K5</td><td>C</td><td>3 x 10</td><td>30</td><td></td><td>K5</td><td>C</td><td>3 x10</td><td>30</td></tr>
<tr><td></td><td>K6</td><td>D</td><td>1 x 10</td><td>10</td><td></td><td>K6</td><td>D</td><td>2x 10</td><td>20</td></tr>
<tr><td></td><td colspan="3"></td><td>100</td><td></td><td colspan="3"></td><td>100</td></tr>
</table>

PROGRAMME OUTCOMES (POs)

After the successful completion of the M.Sc. Physics (Two year) Degree Programme, the graduates will be able to

PO1	**Domain knowledge:** Demonstrate knowledge of basic concepts, principles and applications of the specific science discipline.
PO2	**Resource Utilisation:** Cultivate the skills to acquire and use appropriate learning resources including library, e-learning resources, ICT tools to enhance knowledge-base and stay abreast of recent developments.
PO3	**Analytical and Technical Skills:** Ability to handle/use appropriate tools/techniques/equipment with an understanding of the standard operating procedures, safety aspects/limitations.
PO4	**Critical thinking and Problem solving:** Identify and critically analyse pertinent problems in the relevant discipline using appropriate tools and techniques as well as approaches to arrive at viable conclusions/solutions.
PO5	**Project Management:** Demonstrate knowledge and scientific understanding to identify research problems, design experiments, use appropriate methodologies, analyse and interpret data and provide solutions. Exhibit organisational skills and the ability to manage time and resources.
PO6	**Individual and team work:** Exhibit the potential to effectively accomplish tasks independently and as a member or leader in diverse teams, and in multidisciplinary settings.
PO7	**Effective Communication:** Communicate effectively in spoken and written form as well as through electronic media with the scientific community as well as with society at large. Demonstrate the ability to write dissertations, reports, make effective presentations and documentation.
PO8	**Environment and Society:** Analyse the impact of scientific and technological advances on the environment and society and the need for sustainable development.
PO9	**Ethics:** Commitment to professional ethics and responsibilities.
PO10	**Life-long learning:** Ability to engage in life-long learning in the context of the rapid developments in the discipline.

PROGRAM SPECIFIC OUTCOMES (PSOs):

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

PSO1	Understand principles of Physics for the scientific phenomena in classical domain.
PSO2	Understand the mathematical techniques for describing in depth knowledge of physical concepts.
PSO3	Understand and apply statistical methods for describing the classical and quantum particles in various physical systems and processes.
PSO4	Understand and apply inter-disciplinary concepts and for understanding and describing the natural phenomena.
PSO5	Understand the principles of Quantum mechanics for knowing the physical systems in quantum arena.
PSO6	Provide exposure in various specializations of Physics (Solid State Physics/Nuclear Physics/Particle Physics).
PSO7	Provide exposure to modern experimental/theoretical methods for measurement, observation and fundamental understanding of physical phenomena/systems.
PSO8	Engage in research and life-long learning to adapt to changing environment.

Semester	**19PHYC101 - CLASSICAL AND STATISTICAL MECHANICS**	**L**	**T**	**P**	**C**
I		**4**	**0**	**0**	**4**

Learning Objectives (LO):

LO1	To develop familiarity with the physical concepts and facility with the mathematical methods of classical mechanics
LO2	To demonstrate and apply the classical mechanics towards the solution of motion of rigid bodies
LO3	To Construct a bridge between macroscopic thermodynamics and microscopic statistical mechanics by using mathematical methods and fundamental physics for individual particles.

Course Outcomes (CO) :

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

CO1	formulate scientific questions about the mechanics of a particle and system of particles.
CO2	use D'Alembert's principle to derive the Lagrange equations of motion.

CO3	identify the differences of Bose-Einstein, Fermi-Dirac and Maxwell-Boltzmann statistics.
CO4	describe the relationship between the statistical mechanics and thermodynamics.

UNIT– I: MECHANICS OF A PARTICLE AND SYSTEM OF PARTICLES

Mechanics of a Particle and System of particles – Constraints – Degrees of freedom – Generalized coordinates and its advantages – Hamilton's variational principle – Lagrange's equation of motion – D'Alembert's principle – Applications of Lagrange's equation of motion – Linear harmonic oscillator and simple pendulum. Cyclic co-ordinates – Equivalence of Lagrange's and Newton's equations – Principle of least action.

UNIT– II: CANONICAL TRANSFORMATIONS

Canonical transformation and Conditions for transformation to be canonical with examples – Hamilton-Jacobi method. Hamilton's principal function – Solution of harmonic oscillator problem by Hamilton-Jacobi method – Poisson brackets, Properties and Invariance of Poisson brackets, Equation of motion in Poisson bracket – Small oscillations – Normal modes and Normal Coordinates – Free vibrations of a linear triatomic molecule.

UNIT– III: MAXWELL-BOLTZMANN STATISTICS

Postulates of kinetic theory of gases – Maxwell-Boltzmann distribution of velocities – Derivation of Maxwell – Boltzmann distribution equation – Significance of Maxwell-Boltzmann equation – Phase Space – Ensembles and their types – Liouville's theorem – Statement and Proof.

UNIT– IV: EQUIPARTITION OF ENERGY AND PARTITION FUNCTION

Principle of equipartition of energy – Partition function and their properties – Connection between the partition function and thermodynamic quantities – Mean values obtained from distribution law – Gibb's paradox – Explanation and proof for occurrence of paradox – Sackur-Tetrode equation and its significance.

UNIT– V: QUANTUM STATISTICS

Differentiation of B-E and F-D particles – Derivations of B-E and F-D distributions – Comparison of M-B,B-E and F-D statistics – Black body radiation and the Planck radiation law – Derivation with explanation – Ideal Bose gas – Gas degeneracy – Derivation - Bose Einstein Condensation – Derivation with explanation (Example: Liquid Helium)

CURRENT STREAMS OF THOUGHT (Not for Final Examinations)

Black body radiation: Planck's distribution - Pressure and Energy relationship of Photons - Black body radiation-Rayleigh Jeans formula - Wein's law - Wein's displacement formula - Absorption and Emission of Radiation - Stefan's law - High temperature measurements.

TEXT BOOKS:

1. Gupta, Kumar, Sharma, (2012), *Classical Mechanics*, A Pragati Edition

2. Gupta B.D, and Satya Prakash, (2012), *Classical Mechanics*, Keder Nath publisher, Meerut.
3. Gupta Kumar, (2017), *Elementary Statitiscal Mechanics*, Pragati Prakashan Publisher, Meerut.

SUPPLEMENTARY READING:

1. Kiran C.Guta, (1997), *Classical mechanics of Rigid Bodies*, New Age Publication.
2. Agarwal R.K and Melvin Eisner, (2011), *Statistical Mechanics*, New Age publisher.
3. Gopal, E.S.R, (1976), *Statistical Mechanics and Properties of Matter*, The McMillan Company of India Ltd.
4. Herbert Goldstein, Charles P Poole, John Safko, (2011), *Classical Mechanics*, Pearson Education, Third edition.

COURSE OUTCOME MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	2	1	3	2						3	3	3	3	3	2	3	2
CO2	3	2	1	3							3	3	3	3	3	2	3	
CO3	3	2	1	3	2		2				3	3	3	3	3	2	3	2
CO4	3	2	1	3	2		2				3	3	3	3	3	2	3	2

Note : 3 - Strong, 2 - Medium, 1 - Low

Semester	19PHYC102 – ELECTRONICS	L	T	P	C
I		4	0	0	4

Learning Objectives (LO):

LO1	To acquire in-depth knowledge about semiconductor devices.
LO2	To know about amplifiers, oscillators using transistors.
LO3	To study the applications of operational amplifiers.
LO4	To use with various semiconductor memories
LO5	Turn about the fabrication concepts of Integrated circuits.

Course Outcomes (CO) :

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

CO1	understand the concept of various semiconductor devices by learning their characteristics.
CO2	analyze the parameters of amplifiers, oscillators using transistors and familiarize with applications of operational amplifiers.
CO3	understand the classifications of semiconductor memories.
CO4	understand the concepts of Integrated circuits.

UNIT– I: SEMICONDUCTOR DEVICES

Semiconductor – introduction – types - UJT, JFET, MOSFET - operation and static characteristics. SCR - Two transistor analogy, static characteristics, Half wave, Full wave and bridge rectifier. DIAC, TRIAC - static characteristics.

UNIT– II: AMPLIFIERS AND OSCILLATORS

Transistors: h-parameters - analysis of amplifiers using h-parameters. RC coupled amplifier- single stage-two stage - push pull amplifier - feedback principle and Barkhausen criterion - Hartley, Colpit's and Phase shift oscillators using transistors.

UNIT– III: OPERATIONAL AMPLIFIERS - APPLICATIONS

Operational Amplifier - Characteristics – parameters – applications - Instrumentation amplifier - Differential input and differential output amplifier - V to I and I to V converter - Sample and Hold circuits - Solving simultaneous and differential equation. Applications of IC 741: monostable, bistable Multivibrators, Oscillators - Wein bridge, voltage controlled oscillators, wave form generators - square wave, triangular wave, saw tooth wave.

UNIT– IV: SEMICONDUCTOR MEMORIES

Classification of memories: ROM - RAM. Sampling theorem. DAC - weighted resistor network, binary ladder network. ADC - successive approximation, dual slope, counter method, voltage to frequency conversion method. Programmable Logic Array. Charge Coupled Device memory.

UNIT– V: INTEGRATED CIRCUITS

Classification of ICs - advantages - fabrication of basic monolithic ICs - epitaxial growth - masking and etching - diffusion of impurities. Transistors for monolithic circuit, monolithic diodes, resistors, capacitors and Inductors. Monolithic circuit layout. Logic families - RTL, TTL, CMOS, interfacing CMOS and TTL.

CURRENT STREAMS OF THOUGHT (Not for Final Examinations)

ELECTRONIC MEASUREMENTS

Introduction – Evolution and growth of communication satellites – Assignable satellite frequencies – Equipment on satellite – Propagation of signal - The ground station – Special purpose satellite – Space centres and satellite systems.

TEXT BOOKS:

1. Bhotkar, (2013), *Integrated Circuits*, Khanna Publishers, 10th Edition.
2. Jain, R.P, (2017), *Modern Digital Electronics*, Tata McGraw Hill, 4th Edition.
3. Allen Mottershead, (1991), Electronic Devices And Circuits; An introduction, PHI, 4th edition.

SUPPLEMENTARY READING:

1. Jacob Millman and Grabel, (2017), *Microelectronics*, McGraw Hill, 2nd Edn.
2. Jacob Millman and Halkias, (2017), *Integrated Electronics*, McGraw Hill, 2nd Edn.
3. Gayakwad, (2002), *OP-AMPs and Linear Integrated Circuits*, PHI, India.

COURSE OUTCOME MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	3	3	3	3	3	3	3	1	3	3	3		3			3	3
CO2	3	3	3	3	3	3	3	3	1	3	3	3		3			3	3
CO3	3	3	3	3	3	3	3	3	1	3	3	3		3			3	3
CO4	3	3	3	3	3	3	3	3	1	3	3	3		3			3	3

Note : 3 - Strong, 2 - Medium, 1 - Low

Semester	19PHYC103 - MATHEMATICAL PHYSICS – I	L	T	P	C
I		4	0	0	4

Learning Objectives (LO):

LO1	To develop knowledge in mathematical physics and its applications.
LO2	To develop expertise in mathematical techniques required in physics.
LO3	To enhance problem solving skills.
LO4	To enable students to formulate, interpret and draw inferences from mathematical solutions.

Course Outcomes (CO) :

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

CO1	develop knowledge in mathematical physics and its applications.
CO2	understand the use of complex variables for solving definite integral.
CO3	understand the applications of group theory in all branches of Physics.
CO4	enable students to formulate, interpret and draw inferences from mathematical solutions

UNIT- I: VECTOR ANALYSIS AND VECTOR SPACES

Concept of gradient, divergence and curl - Gauss's divergence theorem, Green's theorem and Stoke's theorem (statement and proof) - Orthogonal curvilinear coordinates - Expression for gradient, divergence, curl and Laplacian in cylindrical and spherical co-ordinates (Theory).

Linearly dependent and independent sets of vectors - Inner product (problems)- Schmidt's orthogonalization process.

UNIT–II: MATRICES

Types of Matrices and their properties, Rank of a Matrix, Eigenvalue Equations and their solutions, Theorems on Matrices; Diagonalisation and Diagonalisation of different matrices; Cayley-Hamilton's theorem; Problems.

UNIT- III: TENSOR ANALYSIS

Definition of Tensors – Contravariant, covariant and mixed tensors – addition and subtraction of Tensors – Summation convention - Symmetry and Anti-symmetry Tensor – Contraction and Direct product – Quotient rule- Pseudo tensors, Levi-Civita Symbol - Dual tensors, irreducible tensors - Metric tensors - Christoffel symbols – Geodesics.

UNIT–IV: COMPLEX VARIABLE

Functions of complex variable - Analytic functions - Cauchy-Riemann equations – integration in the Complex plane - Cauchy's theorem - Cauchy's integral formula – Taylor and Laurent expansions - Singular Points - Cauchy's residue theorem – poles - evaluation of residues – evaluation of definite integrals.

UNIT– V: GROUP THEORY

Definition - Subgroups - Cyclic groups and abelian groups - Homomorphism and isomorphism of groups - Classes - Symmetry operations and symmetry elements - Representations of groups - Reducible and irreducible representations - Character tables for simple molecular types (C_{2v} and C_{3v} point group molecules).

CURRENT STREAMS OF THOUGHT (Not for Final Examinations)

Mathematical probability - compound probability - total probability - sample space - random variables - expectation value, averages, mean, standard deviation, binomial distribution - normal distribution - variance, covariance and correlation - theory of errors, central limit - random process - random variables to random process, statistical averages, stationary processes.

TEXT BOOKS:

1. Satya Prakash, (2017), *Mathematical Physics*, Sultan Chand & Sons, 6th Edition.
2. Gupta, B.D, (2010), *Mathematical Physics*, Vikas Publishing House Private Limited.
3. Rajput, B.S, (2008), *Mathematical Physics*, Pragati Prakashan, 20th Edition.

SUPPLEMENTARY READING:

1. Charlie Harper, (1993), *Introduction to Mathematical Physics*, Prentice Hall of India Private Limited.
2. Pipes L.A. and Havevill, L.R, (2014), *Applied Mathematics for Engineers and Physicists*, McGraw Hill Publications Company, 3rd Edition.
3. Spigel, Murray, R, (1986), *Theory and Problems of Laplace Transforms,* Schaum's outline series, McGraw Hill.

COURSE OUTCOME MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	3	3	2	2	2	1	1	1	2	3	3	3	3	1		2	2
CO2	3	3	3	2	3	1	1	1	1	2	3	3	3	3	1		2	1
CO3	3	3	3	2	3	1	1	1	1	2	3	3	3	3	1		2	1
CO4	3	3	3	3	3	2	1	1	1	2	3	3	3	3	1		2	2

Note : 3 - Strong, 2 - Medium, 1 - Low

Semester	19PHYP104 - PRACTICAL – I	L	T	P	C
I		0	0	3	6

Learning Objectives (LO):

LO1	To gain depth of knowledge regarding the physics fundamentals and instrumentation to arrive solution for various problems.
LO2	To utilize the applications of the experiments
LO3	To understand the usage of basic laws and theories to determine various properties of the materials given
LO4	To providing a hands-on learning experience such as the basic concepts and applications of microprocessor.

Course Outcomes (CO)

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

CO1	understand the laws and theories regarding the various properties of the materials.
CO2	understand the physical significance of the experiments
CO3	apply the theory to design electronic circuits
CO4	provide a hands-on learning experience and understand the basic concepts and applications of microprocessor.

(Any Sixteen Experiments)

1. Young's modulus of a specimen plate- by Newton's interference method.
2. Bi-prism on spectrometer- Wavelength (λ) and Refractive index (μ) of a liquid- using laser source.
3. Charge of an electron- Spectrometer
4. Study of Hall effect in semiconductors.
5. Polarizability of Liquids- Hollow prism on spectrometer.
6. Hg-Cu spectrum- Hartmann's constants and wavelength.
7. Planck's constant.
8. Zeeman Effect.
9. Thermoluminescence
10. Krishnan Torsion Balance.
11. Microprocessor 8085 - Addition, Subtraction, Multiplication & Division
12. Microprocessor 8085 - Logical operation
13. Microprocessor 8085 - Solving expression, Factorial of N Numbers
14. Microprocessor 8085 - Code conversion
15. Microprocessor 8085 – Flashing and Rolling of Name display
16. Microprocessor 8085 – Stepper Motor
17. Microprocessor 8085 – ADC Interfacing
18. Microprocessor 8085 – DAC Interfacing
19. Microprocessor 8085 – Biggest and Smallest Numbers
20. Microprocessor 8085 – Ascending and Descending Order

COURSE OUTCOME MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	3	3	3	3	3	2	3		1	3	2		3		3	3	3
CO2	3	3	3	3	3	3	2	3		1	3	2		3		3	3	3
CO3	3	3	3	3	3	3	3	3		3	3	3		3		3	3	3
CO4	3	3	3	3	3	3	3	3		3	3	3		3		3	3	3

Note : 3 - Strong, 2 - Medium, 1 - Low

Semester	19PHYC201- MATHEMATICAL PHYSICS – II	L	T	P	C
II		4	0	0	4

Learning Objectives (LO):

LO1	To develop knowledge in mathematical physics and its applications.
LO2	To develop expertise in mathematical techniques required in physics.
LO3	To enhance problem solving skills.
LO4	To enable students to formulate, interpret and draw inferences from mathematical solutions.

Course Outcomes (CO) :

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

CO1	develop knowledge in mathematical physics and its applications.
CO2	develop expertise in mathematical techniques required in physics.
CO3	use differential equations and special functions to solve mathematical problems of interest in physics
CO4	enable students to formulate, interpret and draw inferences from mathematical solutions.

UNIT–I: DIFFERENTIAL EQUATIONS

Homogeneous linear equations of second order with constant coefficients and their solutions – ordinary second order differential equation with variable coefficients and their solution by power series and Frobenius methods – extended power series method for indicial equations.

UNIT–II: SPECIALFUNCTIONS – I

Gamma and Beta function - Legendre's differential equation: Legendre polynomials - Generating functions – Recurrence relation - Rodrigue's formula - Orthogonality; Bessel's differential equation: Bessel polynomials - Generating functions – Recurrence relation - Rodrigue's formula – Orthogonality.

UNIT–III: SPECIALFUNCTIONS – II

Hermite differential equation – Generating functions – Hermite polynomials - Recurrence relations – Orthogonality. Rodrigue's formula – Laguerre differential equations – Generating functions - Laguerre polynomials - Recurrence relation - Rodrigue's formula – Orthogonality.

UNIT–IV: PARTIAL DIFFERENTIAL EQUATIONS

Solution of Laplace Differential Equation - Two dimensional flow of heat in Cartesian and cylindrical co-ordinates. Solution of heat flow equation in one dimension - Solution of wave equation - Transverse vibrations of a stretched string (Theory).

UNIT–V: INTEGRAL TRANSFORMS

Fourier transforms - cosine and sine transforms - Linearity theorem - Parseval's theorem - solution of differential equation. Laplace transforms - Definition - Linearity, shifting and change of scale properties. Inverse Laplace transforms – Definition - Problems - Solution of differential equation (problems using the above methods).

CURRENT STREAMS OF THOUGHT (Not for Final Examinations)

Green's function – Definition - Green's function for one – Dimensional case – Properties of Green's function – Solution of inhomogeneous differential equations $\psi'' = f(x)$ – Subject to the homogeneous boundary conditions and subject to the inhomogeneous boundary conditions (without involving derivatives) - Subject to the homogeneous boundary conditions and subject to the inhomogeneous boundary conditions (with involving derivatives).

TEXT BOOKS:

1. Satya Prakash, (2017), *Mathematical Physics*, Sultan Chand & Sons, 6th Edition.
2. Gupta, B.D, (2010), *Mathematical Physics*, Vikas Publishing House Private Limited.
3. Rajput, B.S, (2008), *Mathematical Physics*, Pragati Prakashan, 20th Edition.

SUPPLEMENTARY READING:

1. Charlie Harper, (1993), *Introduction to Mathematical Physics,* Prentice Hall of India Private Limited.
2. Pipes L.A and Havevill, L.R, (2014), *Applied Mathematics for Engineers and Physicists*, McGraw Hill Publications Company, 3rd Edition.
3. Spigel Murray R, (1986), *Theory and Problems of Laplace Transforms*, Schaum's outline series, McGraw Hill.

COURSE OUTCOME MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	3	3	2	2	2	1	1	1	2	3	3	3	3	1		2	2
CO2	3	3	3	2	3	1	1	1	1	2	3	3	3	3	1		2	1
CO3	3	3	3	2	3	1	1	1	1	2	3	3	3	3	1		2	1
CO4	3	3	3	3	3	2	1	1	1	2	3	3	3	3	1		2	2

Note : 3 - Strong, 2 - Medium, 1

Semester	19PHYC202 - QUANTUM MECHANICS – I	L	T	P	C
II		4	0	0	4

Learning Objectives (LO):

LO1	To study the fundamentals of wave mechanics.
LO2	To study the stationary state and eigen spectrum of systems using time dependent Schrodinger equation
LO3	To solve the exactly solvable eigenvalue problems.
LO4	To know the matrix formulation of quantum theory and how it can be used to understand the equation of motion.
LO5	To understand the kinematics of scattering process and partial wave analysis.

Course Outcomes (CO) :

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

CO1	study the stationary state and eigen spectrum of systems using time dependent Schrodinger equation.
CO2	know to solve the exactly solvable eigenvalue problems
CO3	know the matrix formulation of quantum theory and how it can be used to understand the equation of motion.
CO4	understand the theory of kinematics of scattering process and partial wave analysis.

UNIT– I: FOUNDATIONS OFWAVE MECHANICS

Postulates of wave mechanics – adjoint and self – adjoint operators – degeneracy – eigen value, eigenfunctions - Hermitian operator - parity – observables – Physical interpretation – expansion coefficients - momentum eigen functions – Uncertainty principle – states with minimum value – commuting observables.

Matter waves – Equation of motion - Schrodinger equation for the free particle – physical interpretation of wave function - normalized and orthogonal wave functions - expansion theorem - admissibility conditions - stationary state solution of Schrodinger wave equation - expectation values - probability current density - Ehrenfest theorem.

UNIT– II: STATIONARY STATE AND EIGEN SPECTRUM

Time independent Schrodinger equation – Particle in a square well potential – Bound states – eigenvalues, eigen functions – Potential barrier – quantum mechanical tunnelling - alpha emission.

Identical Particles – symmetry and antisymmetric wave functions – exchange degeneracy – Spin and statistics: Pauli's exclusion principle - Slater determinant - spin and Pauli's matrices.

UNIT– III: EXACTLY SOLVABLE EIGENVALUE PROBLEMS

One dimensional linear harmonic oscillator – properties of stationary states - abstract operator method - Angular momentum operators - commutation relation - spherical symmetry systems – Particle in a central potential – radial wave function – Hydrogen atom: solution of the radial equation – stationary state wave functions – bound states - the rigid rotator: with free axis-in a fixed plane - 3-Dimentional harmonic oscillator.

UNIT– IV: MATRIX FORMULATIONOFQUANTUM THEORY, EQUATION OF MOTION & ANGULAR MOMENTUM

Quantum state vectors and functions – Hilbert space - Dirac's Bra-Ket notation - matrix theory of Harmonic oscillator – Equation of motions - Schrodinger, Heisenberg and Interaction representation.

Angular momentum - commutation relation of J_Z, J_+, J_- - eigenvalues and matrix representation of J^2, J_Z, J_+, J_- – Spin angular momentum – spin-½, spin-1 –addition of angular momenta - Clebsch-Gordan coefficients.

UNIT– V: SCATTERING THEORY

Kinematics of scattering process – wave mechanical picture - Green's functions – Born approximation and its validity – Born series – screened columbic potential scattering from Born approximation.

Partial wave Analysis: Asymptotic behaviour – phase shift – scattering amplitude in terms of phase shifts – differential and total cross sections – optical theorem – low energy scattering –resonant scattering – non-resonant scattering - scattering length and effective range – Ramsauer-Townsend effect – scattering by square well potential.

CURRENT STREAMS OF THOUGHT (Not for Final Examinations)

Renormalizability, Counter terms and Physical Perturbation Theory, Vacuum Polarization. Symmetry and Symmetry Breaking: Gauge Symmetry, Global symmetry, Symmetry Breaking, Monopoles, Anderson–Higgs Mechanism, Anomalies.

TEXT BOOKS:

1. Aruldhas, G, (2012), *A Textbook of Quantum Mechanics*, Prentice Hall of India Pvt., Ltd.
2. Satya Prakash, (2018), *Quantum Mechanics*, Kedar Nath Ram Nath and Co. Publications.
3. Thankappan, V.K, (2017), *Quantum Mechanics*, New Age International (P) Ltd. Publication, Second Edition.

SUPPLEMENTARY READING:

1. Ghatak A. K. and Lokanathan, (2015), *Quantum Mechanics –Theory and applications*, Macmillan India Ltd Publication, Fifth Edition.
2. Leonard I. Schiff, (2011), *Quantum Mechanics*, McGraw-Hill International Publication, Third Edition.

3. Merzbacher, E, (2015), *Quantum Mechanics*, John Wiley Interscience Publications, Third Edition.

COURSE OUTCOME MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	2	1	3	2	1	2			2	3	3	3	1	3	3	3	2
CO2	3	2	1	3	2	1	2			2	3	3	3	1	3	3	3	2
CO3	3	2	1	3	2	1	2			2	3	3	3	1	3	3	3	2
CO4	3	2	1	3	2	1	2			2	3	3	3	1	3	3	3	2

Note : 3 - Strong, 2 - Medium, 1 – Low

Semester	19PHYC203 - ELECTROMAGNETIC THEORY	L	T	P	C
II		4	0	0	4

Learning Objectives (LO):

LO1	To understand the nature of electric and magnetic fields and the intricate connection between them.
LO2	To develop a strong background in electromagnetic theory, understand and use various mathematical tools to solve Maxwell equations in problems of wave propagation and radiation.
LO3	To develop skills on solving analytical problems in electromagnetism.

Course Outcomes (CO):

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

CO1	apply vector calculus operations and developing knowledge of vector fields and scalar fields
CO2	describe the fundamental nature of static fields, including steady current, static electric and magnetic fields
CO3	formulate potential problems within electrostatics, magnetostatics and stationary current distributions in linear, isotropic media etc.,
CO4	apply Maxwell's equations and their application to boundary conditions, wave equations, and Poynting's power-balance theorem.

UNIT– I: ELECTROSTATICS

Coulomb's law; the electric field – line, flux and Gauss's law in differential form - the electrostatic potential; conductors and insulators; Gauss's law - application of Gauss's law – curl of E - Poisson's equation; Laplace's equation – work and energy in electrostatics – energy of a point charge distribution – energy of continuous charge distribution – induced charges – capacitors- Potentials: Laplace equation in one dimension and two dimensions – Dielectrics – induced dipoles – Gauss's law in the presence of dielectrics.

UNIT– II: MAGNETOSTATICS

Lorentz force – magnetic fields – magnetic forces – currents – Biot-Savart Law – divergence and curl of B – Ampere's Law – Electromagnetic induction - comparison of magnetostatics and electrostatics – Magnetic vector potential. Magnetization: effect of magnetic field on atomic orbit – Ampere's Law in magnetized materials – ferromagnetism.

UNIT– III: ELECTROMOTIVE FORCE

Ohm's Law – electromotive force – motional emf – Faraday's Law – induced electric field – inductance – energy in magnetic field – Maxwell's equation in free space and linear isotropic media – continuity equation – Poynting theorem.

Electromagnetic waves in vacuum: Waves in one dimension – wave equation – sinusoidal waves – reflection and transmission – Polarization.

UNIT– IV: ELECTROMAGNETIC WAVES

The wave equation for E and B – Monochromatic Plane waves – energy and momentum in electromagnetic waves – electromagnetic waves in matters – TE waves in rectangular wave guides – the co-axial transmission line. Potentials: potentials and fields – scalar and vector potentials – Gauge transformation – Coulomb Gauge and Lorentz Gauge – Lorentz force law in potential form.

UNIT– V: APPLICATION OF ELECTROMAGNETIC WAVES

Boundary conditions at the surface of discontinuity – Reflection and refraction of E.M waves at the interface of non – Conducting media – Kinematic and dynamic properties – Fresnel's equation – Electric field vector 'E' parallel to the plane of incidence and perpendicular to the plane of incidence – Reflection and transmission co-efficients at the interface between two non-conducting media – Brewster's law and degree of polarization – Total internal reflection.

CURRENT STREAMS OF THOUGHT (Not for Final Examinations)

CLASSICAL ELECTRODYNAMICS

Special theory of relativity, Minkowski space and four vectors, concept of four-velocity, four acceleration and higher rank tensors, relativistic formulation of electrodynamics, Maxwell equations in covariant form, gauge invariance and four-potential, the action principle and electromagnetic energy momentum tensor.

TEXT BOOKS:

1. Sathya Prakash, (2019), *Electromagnetic Theory and Electrodynamics*, Kedarnath Ramnath and Co.

2. Laud, B.B, (2011) , *Electromagnetics*, New Age Internatioanal Publisher.
3. Wazed Miah, (1992), *Fundamentals of Electromagnetics*, Tata McGraw Hill.

SUPPLEMENTARY READING:

1. Jackson, J.D, (1993), *Classical Electrodynamics*, Wiley Eastern Limited, II Edition.
2. Narayana Rao, (1997), *Basic Electromagnetics with Application*, (EEE) Prentice Hall.
3. David J. Griffths, (2000), Introduction *to Electrodynamics*, Pearson, 4th Edn.

COURSE OUTCOME MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	3	1	1	1	1	3	1	1	3	3	3	3	3	2	3	3	2
CO2	3	3	2	2	2	2	3	2	1	3	3	3	3	3	2	3	3	2
CO3	3	3	2	2	2	2	3	2	1	3	3	3	3	3	2	3	3	2
CO4	3	3	1	1	1	1	3	1	1	3	3	3	3	3	2	3	3	2

Note : 3 - Strong, 2 - Medium, 1 – Low

Semester	19PHYP204 - PRACTICAL – II	L	T	P	C
II		0	0	3	6

Learning Objectives (LO):

LO1	To gain depth of knowledge regarding the physics fundamentals and an instrumentation to arrive solution for various problems.
LO2	To study the aspects related to the application side of the experiments
LO3	To understand the usage of basic laws and theories to determine various properties of the materials given.
LO4	To providing a hands-on learning experience such as in measuring the basic concepts and applications of laser and microprocessor.

Course Outcomes (CO):

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

CO1	understand the basic laws and theories regarding the various properties of the materials
CO2	understand the given concepts and its physical significance
CO3	apply the theory to design electronic circuits
CO4	provide a hands-on learning experience and understand the basic concepts and applications of laser and microprocessor.

(Any Sixteen Experiments)

1. Michelson Interferometer – Wavelength Determination.
2. Energy gap – Four Probe Apparatus.
3. Elastic constants of Glass - Cornu's interference method (Hyperbolic fringes).
4. Solar Spectrum
5. Thermistor characteristics-Band gap energy
6. Reflection grating-Spectrometer
7. Ultrasonic diffractometer – Velocity and compressibility of liquids
8. Determination of wavelength – laser source.
9. Particle size analyzer using Laser
10. Magnetostriction
11. Numerical Aperture and Acceptance Angle - Fibre Optics
12. Microprocessor 8086 – Addition and Subtraction (16 & 32 bits)
13. Microprocessor 8086 – Multiplication and Division (16 & 32 bits)
14. Microprocessor 8086 - Biggest and Smallest Number
15. Microprocessor 8086 - Code conversion
16. Microprocessor 8086 - Solving expression, Factorial of n numbers
17. Microprocessor 8086 – Sum of elements in an array and factorial
18. Microprocessor 8086 – Sorting of n Elements (Ascending and Descending Order)
19. Microprocessor 8086 – String Operations
20. Wave form generation using 8086.

COURSE OUTCOME MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	3	3	3	3	3	2	3		1	3	2		3		3	3	3
CO2	3	3	3	3	3	3	2	3		1	3	2		3		3	3	3
CO3	3	3	3	3	3	3	3	3		3	3	3		3		3	3	3
CO4	3	3	3	3	3	3	3	3		3	3	3		3		3	3	3

Note : 3 - Strong, 2 - Medium, 1 – Low

Semester	19PHYC301 - CONDENSED MATTER PHYSICS – I	L	T	P	C
III		4	0	0	4

Learning Objectives (LO):

LO1	This course gives an insight into the basic elements of the physics of solid and in particular the study of the structure of crystalline solids and their

	physical properties.
LO2	To develop a deep understanding of how condensed matter is characterized on the atomic scale.
LO3	Understanding of Lattice vibrations, approximations, phonons and heat capacity to know the correlation between the structure and thermal properties of the materials.

Course Outcomes (CO) :

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

CO1	describe different types of crystal structures.
CO2	understand the types of lattice vibrations and heat conduction.
CO3	describe and understand the various imperfections in crystals.
CO4	understand the band-structure of the solid.

UNIT– I: CRYSTAL PHYSICS: CRYSTAL STRUCTURE

Lattice representation - Simple symmetry operations - Bravais Lattices, Unit cell, Wigner-Seitz cell - Miller planes and spacing - Characteristics of cubic cells - Structural features of NaCl, CsCl, Diamond, ZnS – Close packing.

Crystal Binding*:* Interactions in inert gas crystals and cohesive energy – Lennard – Jones potential - Interactions in ionic crystals and Madelung energy - Covalent bonding – Heitler – London Theory – Hydrogen bonding – metallic bonding.

UNIT– II: DIFFRACTION OF WAVES AND PARTICLES BY CRYSTALS

X-rays and their generation - Moseley's law – Absorption of X-rays (Classical theory) – Absorption Edge – X-ray diffraction – The Laue equations – Equivalence of Bragg and Laue equations – Interpretation of Bragg equation – Ewald construction - Reciprocal lattice – Reciprocal lattice to SC, BCC and FCC crystals - Important properties of the Reciprocal lattice – Diffraction Intensity - The Powder method – Powder Diffractometer - The Laue method -The Rotating Crystal method - Neutron Diffraction - Electron diffraction.

UNIT– III: CRYSTAL IMPERFECTIONS AND ORDERED PHASES OF MATTER

Point imperfections – Concentrations of Vacancy, Frenkel and Schottky imperfections – Line Imperfections – Burgers Vector – Presence of dislocation – surface imperfections - Polarons – Excitons. Ordered phases of matter - Translational and orientation order - Kinds of liquid crystalline order - Quasi crystals - Superfluidity.

UNIT– IV: LATTICE DYNAMICS

Theory of elastic vibrations in mono and diatomic lattices - Phonons – Dispersion relations - Phonon momentum.

Heat Capacity

Specific heat capacity of solids – Dulong and Petit's law - Vibrational modes - Einstein model - Density of modes in one and three dimensions - Debye Model of heat capacity.

Anharmonic Effects

Explanation for Thermal expansion - Conductivity and resistivity – Umklapp process.

UNIT– V: THEORY OF ELECTRONS

Energy levels and Fermi-Dirac distribution for a free electron gas – Periodic boundary condition and free electron gas in three dimensions – Heat capacity of the electron gas – Ohm's law, Matthiessen's rule – Hall effect and magnetoresistance – Wiedemann – Franz law.

Nearly free electron model and the origin and magnitude of energy gap – Bloch functions - Bloch theorem - Motion of an electron in a periodic potential – Kronig – Penney model - Approximate solution near a zone boundary – Metals, semiconductors and insulators – effective mass – Limitations of K-P model – Tight binding approach - Construction of Fermi surface - Reduced and periodic zone schemes of construction - de Haas – van Alphen effect.

CURRENT STREAMS OF THOUGHT (Not for Final Examinations)

CONTEMPORARY TOPICS

Quasi electrons and Plasmons – Magnons – Super fluidity - Disordered system of various levels.

TEXT BOOKS:

1. Wahab, M.A, (1999), *Solid State Physics, Structure and Properties of the Materials*, Narosa, New Delhi.
2. Saxena, Gupta, Saxena, (2016), *Fundamentals of Solid State Physics*, Pragati Prakhasan,
3. Dekker, A.J, (2008), *Solid State Physics*, Macmillan Publishers India Pvt. Ltd.

SUPPLEMENTARY READING:

1. Charles Kittle, (2004), *Introduction to Solid State Physics*, Wiley India Pvt. Ltd., New Delhi, 7^{th} Edition.
2. Pillai, S.O, (1994), *Problems and Solutions in Solid State Physics*, New Age International Publishers, New Delhi.
3. Patterson, J.D., B.C. Bailey, (2007), *Solid State Physics: Introduction to the Theory*, Springer Publication.

COURSE OUTCOME MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	3	3	3	3	2	2	3	1	3	3	1		3	3	3	3	3
CO2	3	3	3	3	3	2	2	3	1	3	3			3	3	3	3	3
CO3	3	3	3	3	3	2	2	3	1	3	3	1		3	3	3	3	3
CO4	3	3	3	3	3	2	2	3	1	3	3	1		3	3	3	3	3

Note : 3 - Strong, 2 - Medium, 1 - Low

Semester	19PHYC302 - QUANTUM MECHANICS – II	L	T	P	C
III		4	0	0	4

Learning Objectives (LO):

LO1	To learn about the approximation methods for time independent and time dependent perturbation theory.
LO2	To understand the concept and applications of variation and WKB methods.
LO3	To study the theory of relativistic quantum mechanics and field quantization.
LO4	To study the quantum theory of atomic and molecular structures.

Course Outcomes (CO) :

At the end of the course, the students will be able [1]to

CO1	apply and appreciate the approximation methods to various problems
CO2	identify the time dependent and time independent cases
CO3	grasp the developments in relativistic quantum mechanics
CO4	evaluate the quantum field parameters

UNIT– I: TIME INDEPENDENT QUANTUM APPROXIMATION METHODS

Time independent perturbation theory – Stationary theory - Non-degenerate case - first and second order – Normal Helium atom – Zeeman effect without electron spin – perturbed harmonic oscillator - Degenerate case - Energy correction - Stark effect in hydrogen atom.

UNIT– II: TIME DEPENDENT QUANTUM APPROXIMATION METHODS

Time dependent Perturbation theory – first order transitions – constant perturbation - transition probability - Fermi Golden Rule – harmonic perturbation – adiabatic and sudden approximation – charged particle in a electromagnetic field.

Semiclassical theory of radiation: Application of the time dependent perturbation theory to semi-classical theory of radiation – Einstein's coefficients – absorption - induced emission - spontaneous emission - Einstein's transition probabilities - dipole transition - selection rules – for bidden transitions.

UNIT– III: VARIATION METHOD

Variation method: Variation Principle - ground state of Helium atom – Hydrogen molecule - Heitlor-London model - WKB approximation - Schrodinger equation - Asymptotic solution - validity of WKB approximation - solution near a turning point – connection formula for penetration barrier – Bohr-Sommerfeld quantization condition - tunneling through a potential barrier.

UNIT– IV: QUANTUM THEORY OF ATOMIC AND MOLECULAR STRUCTURE

Central field approximation: Residual electrostatic interaction - spin-orbit interaction - Determination of central field: Thomas Fermi statistical method - Hartree and Hartree-Fock approximations (self consistent fields) – Atomic structure and Hund's rule.

Born-Oppenheimer approximation – An application: the hydrogen molecule on (H_2^+) – Molecular orbital theory: LCAO.

UNIT– V: RELATIVISTIC QUANTUM MECHANICS & QUANTIZATION OF THE FIELD

Schrodinger relativistic equation - Klein-Gordan equation - charge and current densities – interaction with electromagnetic field - Hydrogen like atom – non relativistic limit - Dirac relativistic equation: Dirac relativistic – Hamiltonian – probability density - Dirac matrices - plane wave solution – eigenspectrum – spin of Dirac particle – significance of negative eigen states – electron in a magnetic field – spin magnetic moment.

Quantization of wave fields - Classical Lagrangian equation - Classical Hamiltonian equation - Field quantization of the non-relativistic Schrodinger equation - Creation, destruction and number operators – Anticommutation relations- Quantization of Electromagnetic field - energy and momentum.

TEXT BOOKS:

1. Mathews P. M. and K. Venkatesan, (2010), *A Text book of Quantum Mechanics*, Tata McGraw – Hill Publications, 2nd Edition.
2. Satya Prakash, (2018), *Quantum Mechanics*, Kedar Nath Ram Nath and Co. Publications.
3. Claude Cohen-Tannoudji, Bernard Diu, Franck Laloë, (2011) *Quantum Mechanics* (*Vol. II),* John Wiley Publications.

SUPPLEMENTARY READING:

1. Thankappan, V.K, (2014), *Quantum Mechanics*, New Academic Science Ltd. Publication, 4th Edition.
2. Ghatak A.K and Lokanathan, (2015), *Quantum Mechanics–Theory and Applications*, Macmillan India Ltd. Publication, 5th Edition.
3. Merzbacher, E, (2011), *Quantum Mechanics*, John Wiley Interscience Publications, 3rd Edition.

COURSE OUTCOME MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	2	1	3	2	1	2			2	3	3	3	1	3	3	3	2
CO2	3	2	1	3	2	1	2			2	3	3	3	1	3	3	3	2
CO3	3	2	1	3	2	1	2			2	3	3	3	1	3	3	3	2
CO4	3	2	1	3	2	1	2			2	3	3	3	1	3	3	3	2

Note : 3 - Strong, 2 - Medium, 1 – Low

Semester	19PHYC303 - NUCLEAR AND ELEMENTARY PARTICLE PHYSICS	L	T	P	C
III		4	0	0	4

Learning Objectives (LO):

LO1	To understand the force that binds the nucleons in detail and the perspective of various models proposed with dipole and quadropole moments of the nucleus
LO2	To make them realize the cause of various nuclear particles in the strong short range interaction among the nucleons.
LO3	To understand the concepts of elementary particles.

Course Outcomes (CO):

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

CO1	understand the properties of nucleus and nuclear forces and their dependence on various parameters.
CO2	compare various nuclear models and picture a good model.
CO3	understand the nuclear energy sources through various nuclear reactions.
CO4	know the causes for short range interaction inside the nucleons with mathematical formulations.

UNIT– I: NUCLEAR FORCES

Characteristics of nuclear forces – Exchange forces and tensor forces – saturation of nuclear forces - charge independence - Ground state of deuteron – properties – theory - Nucleon-Nucleon scattering: types of cross-section – neutron-proton scattering at low energies - Effective range theory of n-p scattering at low energies.

UNIT– II: NUCLEAR MODELS

Binding energy & mass defect - Weizacker's mass formula - mass parabola – Nuclear models: Liquid drop model – Shell model - spin–orbit coupling - spins of nuclei - Magnetic moments - Schmidt lines- Electric quadrupole moments - Collective model - Nuclear vibrational-rotational states – Nilsson model.

UNIT– III: NUCLEAR REACTIONS

Introduction to Nuclear reaction - Nuclear reaction cross section - Direct Nuclear reactions theory - Knock out reaction, Pick-up reaction, Stripping reaction - Compound nucleus theory - Reciprocity theorem - Formation - Disintegration energy levels - Resonance scattering and Reaction cross-section – Breit-Wigner dispersion formula.

UNIT– IV: NUCLEAR FISSION AND FUSION

Nuclear fission - Energy release in fission reaction - Distribution of fission products - neutron emission in fission - Fissile and fertile materials – Bohr-Wheeler theory - Nuclear reactors – Classification of reactors - Critical size of a reactor - Reactor materials.

Nuclear fusion - fusion reactors - Pinched discharge - Stellarator - Magnetic mirror systems.

UNIT– V: ELEMENTRY PARTICLE PHYSICS

Classification of elementary particles - Types of interaction between elementary particles - Hadrons and leptons - Symmetry and conservation laws - Strangeness and associate production - CPT theorem - classification of hadrons - Quark model.

Isospin multiples - SU(2) - SU(3) multiplets - Gell-Mann - Okubo mass formula for octet and decuplet hadrons - Phenomenology of weak interaction hadrons and leptons - Universal Fermi interaction - Elementary concepts of weak interactions.

CURRENT STREAMS OF THOUGHT (Not for Final Examinations)

EFFECTS OF NUCLEAR RADIATION

Radiation therapy for cancer – Cancer therapy with protons, neutrons and heavy ions.

TEXT BOOKS:

1. Tayal, D.C, (2018), *Nuclear* Physics, Himalaya Publishing House Pvt. Ltd., V-Edition.
2. Pandya, L and Yadav, P.R.S, (2016), *Elements of Nuclear Physics*, Kedar Nath Ram Nath publications, Meerut.
3. Kuila, S.P, (2015), *Concepts of Nuclear Physics*, New Central Book Agency Pvt. Ltd., Kolkata.

SUPPLEMENTARY READING:

1. Griffiths, D, (2008), *Introduction to Elementary Particles*, Wiley-Vch, II-Edition.
2. Srivatsava, B.N, (2016), *Basic Nuclear Physics and Cosmic Rays*, Pragati Prakashan publications, Meerut, XVII-Edition:

4. Irving Kaplan, (1977), *Nuclear Physics*, Addsion-Wesley Publising company, II Edition

COURSE OUTCOME MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	3	3	3	3	3	3	3	3	3	3	3	1	3	2	3	3	3
CO2	3	3	3	3	3	3	3	3	3	3	3	3	1	3	2	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3	3	1	1	3	2	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3	3	3	1	3	2	3	3	3

Note : 3 - Strong, 2 - Medium, 1 - Low

Semester	19PHYP304 - PRACTICAL – III	L	T	P	C
III		0	0	3	6

Learning Objectives (LO):

LO1	To gain depth of knowledge regarding the physics fundamentals and an instrumentation to arrive solution for various problems.
LO2	To study the aspects related to the application side of the experiments
LO3	To understand the usage of basic laws and theories to determine various properties of the materials given.
LO4	To providing a hands-on learning experience such as in measuring the basic concepts and applications of microcontroller.

Course Outcomes (CO):

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

CO1	understand basic laws and theories regarding the various properties of the materials
CO2	understand the given concepts and its physical significance
CO3	apply the theory to design electronic circuits
CO4	provide a hands-on learning experience and understand the basic concepts and applications of microcontroller.

(Any Sixteen Experiments)

1. Low field Hysterisis
2. Susceptibility of liquids using Guoy-Balance
3. Susceptibility of liquids by Quinke's method
4. Photo elastic constant

5. Hysterisis loop tracer
6. Cu-Salt (visible) Spectrum
7. Molecular constants - CN Band
8. Channel Spectrum
9. R.F.Oscillator- determination of dielectric constant.
10. Ultrasonic velocity of liquid mixtures - Interferometer
11. Phase diagram of single component - using Potentiometer.
12. G.M. Counter characteristics
13. Microcontroller 8051 Experiment-I (Addition and Subtraction and Logical operations)
14. Microcontroller 8051 Experiment-II (Multiplication and Division and Solving expressions)
15. Microcontroller 8051 Experiment-III (Logical operations, 1’s and 2’s compliment)
16. Array Operations-I Microcontroller 8051(Sum of elements, biggest and smallest numbers)
17. Array Operations-II Microcontroller 8051(Ascending and descending order)
18. Microcontroller 8051 - Code conversion
19. Microcontroller 8051 – ADC interfacing
20. Microcontroller 8051 - Stepper motor interfacing

COURSE OUTCOME MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	3	3	3	3	3	2	3		1	3	2		3		3	3	3
CO2	3	3	3	3	3	3	2	3		1	3	2		3		3	3	3
CO3	3	3	3	3	3	3	3	3		3	3	3		3		3	3	3
CO4	3	3	3	3	3	3	3	3		3	3	3		3		3	3	3

Note : 3 - Strong, 2 - Medium, 1 - Low

Semester	19PSC0300 - CONSTITUTION OF INDIA	L	T	P	C
III		2	0	0	2*

Learning Objectives (LO):

LO1	To understand the basic features of Indian Constitution
LO2	To grasp about the basic Rights and Duties of Indian Citizenry.
LO3	To ponder over the form of Indian Political System.
LO4	To have broad understanding about the pivotal provisions related with liberty, equality and fraternity.

Course Outcomes (CO):

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

CO1	imbibe with the basic features of Indian Political System
CO2	enlighten themselves with the rights and duties of Indian citizens.
CO3	understand the significance of rule of law.
CO4	inculcate with basic liberties.

Unit I:

Constitution of India – Basic Features and Fundamental Principles - Making of Indian Constitutional Law and Constitutionalism - Historical Perspective of the Constitution of India – Salient features and Characteristics of the Constitution of India.

Unit II:

Fundamental Rights and Duties - Scheme of Fundamental Rights -The Scheme of Fundamental Duties and its legal status - The Directive Principles of State Policy – Its Importance and Implementation.

Unit III:

Legislative and Financial Powers of States - Federal Structure and Distribution of Legislative and Financial powers between the Union and the States - Parliamentary form of Government of India - The Constitution powers and States of the President of India.

Unit IV:

Constitutional Amendments in India - The Historical Perspectives of the Constitutional Amendments in India – Emergency Provisions - National Emergency, President Rule - Financial Emergency.

Unit V:

Fundamental Rights - Schemes of the Fundamental Right to Equality – Scheme of the Fundamental Rights to certain Freedom under Article 19 – Scope of the Right to Life and Personal Liberty under Article 21.

CURRENT STREAMS OF THOUGHT (Not for Final Examinations)

Recent Amendments in Constitution of India

Faculty member will impart the knowledge on Recent Amendments in Constitution of India to the students.

Text Books:

1. Bipan Chandra, Mridula Mukherjee, Adility Makherjee (2016), *India After Independence 1947- 2000,* Penguin Publishers, New Delhi.
2. Durga Das Basu, (2018), *Introduction to the Constitution of India*, Prentice Hall, New Delhi.
3. Jogendra Yadav, (2000), *Transforming India: Dynamics of Democracy*, Oxford University Press, New Delhi.

SUPPLEMENTARY READING:

1. *The Constitution of India,* (1950), (Bare Act), Government of India Publications.
2. Busi S.N Ambedkar B.R, (2015), *Framing of Indian Constitution.*
3. Jain M.P, (2014*), Indian Constitution Law*, Lexis Nexis.
4. Paul R.Brass, (1999), *The Politics of India Since Independence*, Cambridge University Press, UK.
5. Granvila Austin, (2006), *The Indian Constitution :Cornerstone of a Nation*, Oxford University Press, New Delhi.

COURSE OUTCOME MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1		3	3		2					2					**2**			
CO2		3	2		3	2					3			3	**2**			
CO3	3	2		3	2					2			**3**	2	**2**			

Note : 3 - Strong, 2 - Medium, 1 - Low

Semester	19PHYC401 - CONDENSED MATTER PHYSICS – II	L	T	P	C
IV		4	0	0	4

Learning Objectives (LO):

LO1	This course develops analytical thinking to understand the phenomenon that decide various properties of solids.
LO2	Provides a valuable theoretical introduction and overview of the fundamental application of physics of solids.
LO3	To impart the basic knowledge about superconductors and high temperature super conductors.

Course Outcomes (CO):

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

CO1	understand the dielectric properties of the solid systems.
CO2	understand the ferroelectric and piezoelectric properties of the solid systems and its application.
CO3	understand deeply the electrical and magnetic properties of crystalline solids with theoretical background.
CO4	understand the theoretical basis of nanotechnology and carbon in nanotechnology.

UNIT– I: THEORY OF DIELECTRICS

Dipole moment – Polarization – The electric field of a dipole – Local electric field at an atom – Clausius –Mosotti equation - Dielectric constants and its measurements - Polarizability – The Classical theory of electronic polarizability – Ionic polarizabilities - Orientational polarizabilities - The polarizability catastrophe - Dipole orientation in solids - Dipole relaxation and dielectric losses – Debye Relaxation time - Relaxation in solids - Complex dielectric constants and the loss angle - Frequency and temperature effects on Polarization – Dielectric breakdown and dielectric loss.

UNIT– II: THEORY OF FERROELECTRICS AND PIEZO ELECTRICS

Ferroelectric Crystals – Classifications of Ferroelectric crystals - Dipole theory of ferroelectricity – Landau Theory of the phase transition – Second order Transition – First Order Transition - Ferroelectric Transition - One-Dimensional Model of the Soft Mode of Ferroelectric Transitions – Antiferroelectricity - Ferroelectric domains – Ferroelectric domain wall motion – Piezoelectricity - Phenomenological Approach to Piezoelectric Effects - Piezoelectric Parameters and Their Measurements - Piezoelectric Materials

UNIT– III: MAGNETIC PROPERTIES OF MATERIALS

Terms and definitions used in magnetism – Classification of magnetic materials – Atomic theory of magnetism – The quantum numbers- The origin of permanent magnetic moments – Langevin's classical theory of diamagnetism – Sources of paramagnetism – Langevin's classical theory of paramagnetism – Quantum theory of paramagnetism – Paramagnetism of free electrons - Ferromagnetism – The Weiss molecular field theory – Temperature dependence of Spontaneous magnetization – The physical origin of Weiss Molecular field - Ferromagnetic domains - Domain theory – Antiferromagnetism – Ferrimagnetism – Structure of Ferrite.

UNIT– IV: SUPERCONDUCTIVITY

Occurence of super conductivity - Destruction of super conductivity by magnetic fields - Meissner Effect – Type I and Type II Super conductors - Heat Capacity - Energy gap - Microwave and infrared properties - Isotope effect - Thermodynamics of the superconducting transition - London equation - Coherence Length - BCS theory of superconductivity, BCS ground state - Flux quantisation in a super conduction ring - Duration of persistence currents -

Single particle tunnelling - DC Josephson effect - AC Josephson effect - Macroscopic quantum interference – High temperature super conductors – Applications.

UNIT– V: PHYSICS OF NANOSOLIDS

Definition of nanoscience and nanotechnology – Preparation of nanomaterials – Surface to volume ratio – Quantum confinement – Qualitative and Quantitative description – Density of states of nanostructures – Excitons in Nano semiconductors – Carbon in nanotechnology – Buckminsterfullerene – Carbon nanotubes – Nano diamond – BN nano tubes – Nanoelectronics – Single electron transistor – Molecular machine – nano biometrics.

CURRENT STREAMS OF THOUGHT (Not for Final Examinations)

CONTEMPORARY TOPICS

Density functional theory – latest experimental techniques in condensed matter physics – Advanced optical and electronic properties.

TEXT BOOKS:

1 Wahab, M.A, (1999), *Solid State Physics, Structure and Properties of the Materials*. Narosa, New Delhi.
2 Saxena, Gupta, Saxena, (2016), *Fundamentals of Solid State Physics*, Pragati Prakhasan.
3 Dekker, A, (2008), Solid State Physics, Macmillan Publishers India Pvt. Ltd.

SUPPLEMENTARY READING:

1 Charles Kittle, (2004), *Introduction to solid state physics*, Wiley India Pvt. Ltd., New Delhi, 7^{th} Edition.
2 Pillai, S.O, (1994), *Problems and Solutions in Solid State Physics*, New Age International Publishers, New Delhi.
3 Patterson, J.D and B.C Bailey, (2007), *Solid-State Physics: Introduction to the Theory*, Springer Publication.

COURSE OUTCOME MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	3	3	3	3	2	2	3	1	3	3	1		3	3	3	3	3
CO2	3	3	3	3	3	2	2	3	1	3	3			3	3	3	3	3
CO3	3	3	3	3	3	2	2	3	1	3	3	1		3	3	3	3	3
CO4	3	3	3	3	3	2	2	3	1	3	3	1		3	3	3	3	3

Note : 3 - Strong, 2 - Medium, 1 - Low

Semester	19PHYC402 - SPECTROSCOPY	L	T	P	C
IV		4	0	0	4

Learning Objectives (LO):

LO1	To educate the students about the fundamental aspects of Vibrational and Vibration-Rotational Spectroscopy.
LO2	To impart knowledge regarding the fundamental aspects of Resonance Spectroscopy.
LO3	To expose the students to the effective applications of various Molecular Spectroscopic techniques to study the chemical and structural properties of materials.

Course Outcomes (CO):

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

CO1	outline the fundamental principles of Vibrational and Vibration-rotational spectroscopy
CO2	describe the fundamental principles of Resonance Spectroscopy.
CO3	identify the applications of appropriate spectral technique for the characterisation of materials.
CO4	assess and recommend suitable solution to interdisciplinary problems.

UNIT– I: INFRARED SPECTROSCOPY

Vibrational energy of a diatomic molecule – IR selection rules - Vibrating diatomic molecule - Diatomic vibrating rotator - Vibrations of polyatomic molecules - Fermi resonance - Rotation vibration spectra of polyatomic molecules - Normal modes of vibration in crystal - Interpretation of vibrational spectra - Group frequencies - IR spectrophotometer-Instrumentation - Fourier Transform Infrared spectroscopy – Applications.

UNIT– II: RAMAN SPECTROSCOPY

Introduction - Theory of Raman scattering - Rotational Raman spectra - Vibrational Raman spectra - Mutual exclusion principle - Raman spectrometer - Sample handling techniques - Polarization of Raman scattered light - Structure determination using IR and Raman spectroscopy - Raman investigation of phase transitions - Resonance Raman scattering - Nonlinear Raman phenomena – Preliminaries: Hyper Raman effect - Stimulated Raman scattering – Inverse Raman effect - Coherent Anti-Stokes Raman scattering.

UNIT– III: ELECTRON SPIN RESONANCE SPECTROSCOPY

Basic principle – Quantum theory - g-factor – Nuclear Interaction and Hyperfine structure – Line width - Relaxation effects – Hyperfine interaction - ESR spectrometer – Instrumentation – applications.

UNIT– IV: NMR AND NQR SPECTROSCOPY

NMR : Basic principle – Quantum theory of NMR – magnetic resonance - relaxation processes – Chemical shift – spin-spin coupling – NMR instrumentation - FTNMR – applications.

NQR : Nuclear Electric quadrupole interaction – Basic theory - Energy levels and selection rules – fundamental requirements - Instrumentation – applications.

UNIT – V : MOSSBAUER SPECTROSCOPY

Mossbauer effect - recoilless emission and absorption - hyperfine interaction - chemical isomer shift – Quadrupole effects – Instrumentation – applications.

CURRENT STREAMS OF THOUGHT (Not for Final Examinations)

SOME ASPECTS OF SPECTROSCOPIC TECHNIQUES

Principle, Instrumentation and Application: Nuclear Magnetic Double Resonance (NDMR) and INDOR spectroscopy - Electron Nuclear Double Resonance (ENDOR) - ELDOR spectroscopy - Femtosecond spectroscopy.

TEXT BOOKS:

1. Colin N. Banwell and Elaine M. Mc Cash, (2016), *Fundamentals of Molecular Spectroscopy*, McGraw-Hill Education (India) Pvt. Ltd.,New Delhi, (5^{th}edition).
2. Straughen R.P and S. Walker, (1976), *Spectroscopy (vol.I, II, III),* Chapman & Hall , London.
3. Gurdeep R. Chatwal and Sham.K.Anand, (2016), *Spectroscopy (Atomic and Molecular),* Himalaya Publishing House, 5^{th} edition.

SUPPLEMENTARY READING:

1. Michael Hollas, (2015), *Modern Spectroscopy*, John Wiley, New York, (4^{th} edition), Reprint.
2. Walter S. Struve, (1989), *Fundamentals of Molecular Spectroscopy*, John Wiley and Sons, Ames, Iowa.
3. Aruldhas, G, (2007), *Molecular Structure and Spectroscopy*, PHI Learning Private Limited – Hall of India, 2^{nd} edition.

COURSE OUTCOME MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	3	3	3	3	3	3	3	2	3	3	2	2	3	2	3	3	3
CO2	3	3	3	3	3	3	3	3	2	3	3	2	2	3	2	3	3	3
CO3	3	3	3	3	3	3	3	3	2	3	3	2	2	3	2	3	3	3
CO4	3	3	3	3	3	3	3	3	2	3	3	2	2	3	2	3	3	3

Note : 3 - Strong, 2 - Medium, 1 - Low

Semester	19PHYC403 - PHYSICS OF NANOMATERIALS	L	T	P	C
IV		4	0	0	4

Learning Objectives (LO):

LO1	To distinguish nanomaterials from bulk materials.
LO2	To apply their acquired knowledge in research level to synthesis and characterize the nanomaterials.
LO3	To identify the various techniques to investigate the different properties such as optical, structural and morphology of nanoparticles.
LO4	To select the nanomaterials for various applications.

Course Outcomes (CO):

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

CO1	distinguish nanomaterials from bulk materials..
CO2	apply their acquired knowledge in research level to synthesis and characterize the nanomaterials.
CO3	identify the various techniques to investigate the different properties such as optical, structural and morphology of nanoparticles
CO4	select the nanomaterials for various applications.

UNIT– I: INTRODUCTION

Introduction – History of nanotechnology - Classification of nanomaterials: Definition of – zero, one and two dimension nano structures – examples - Surface energy – Chemical potential as a function of surface curvature – Electrostatic stabilization - Steric stabilization – DLVO theory.

UNIT– II: SPECIAL NANOMATERIALS

Carbon Fullerenes and Nanotubes: Carbon fullerenes, Fullerene derived crystals, Carbon nanotubes. Micro and mesoporous materials: Ordered mesoporous structures, Random mesoporous structures, and crystalline microporous materials. Core-shell structures: Metal - oxide structures, Metal-polymer structures, Oxide-polymer structures.

UNIT – III: PROPERTIES

Physical properties of nanomaterials: Melting points, Lattice constants – Mechanical properties – Optical properties: Surface plasmon resonance – Quantum size effects – Electrical property: Surface scattering, charge of electronic structure - Ferroelectrics and dielectrics: Variation of magnetism with size - Super para magnetism - Diluted magnetic semi conductor.

UNIT – IV: SYNTHESIS

Synthesis of nano materials: Physical vapour deposition - Chemical vapour deposition - Sol gel - Ball milling technique - Reverse miceller technique - Electro deposition. Nanostructures fabrication by physical techniques – Nano lithography – Nanomanipulator.

UNIT – V: CHARACTERIZATION AND APPLICATIONS

Structural characterization: X-Ray diffraction – Scanning electron microscopy (SEM) – Transmission electron microscopy (TEM) – Chemical characterization: Optical spectroscopy: UV-Visible and Photoluminescence spectroscopy.

Applications: Molecular electronics and Nano electronics, Nano electromechanical systems - Colorants and pigments – DNA chips – DNA array devices – Drug delivery systems.

CURRENT STREAMS OF THOUGHT (Not for Final Examinations)

Nanotechnology: Magnetic sensors and its applications – Bio sensors and its applications - Photonic crystals – Plasmon wave guides.

TEXT BOOKS:

1. Viswanathan B, (2014), *Nano Materials*, Narosa publishing House Pvt. Ltd.
2. Pradeep T, (2012), *Nano: The Essentials*, Tata MCGraw-Hill Publishing Company limited.
3. Christof M. Niemeyer, Chad A. Mirkin, (2004), *Nanobiotechnology: Concepts, Applications and Perspectives*, Wiley-VCH Verlag GmbH & Co.
4. Kalantar–Zadeh, Kourosh, Fry, Benjamin, (2008), *Nanotechnology–Enabled Sensors*, Springer.

SUPPLEMENTARY READING:

1. Kenneth F. Klablunde, (2009), *Nanoscale Materials in Chemistry*, John Wiley and sons, Inc.,
2. Bandyopadhyay, A K, (2016), *Nano Materials*, New Age International Publisher(P) Ltd.

3. Maria Benelmekki, (2019), *Nanomaterials: The Origional Product of Nanotechnology*, Morgan & Claypool.
4. Vijay, K, Varadhan, Linfeng Chen and Sivathanupillai, (2010), *Nanotechnology Engineering in Nano and Biomedicine*, John Wiley & sons.

COURSE OUTCOME MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3
CO2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	1	3
CO3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3
CO4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	1	3

Note : 3 - Strong, 2 - Medium, 1 – Low

Semester	19PHYP404 - PRACTICAL – IV	L	T	P	C
IV		0	0	3	6

Learning Objectives (LO):

LO1	To gain knowledge regarding the fundamentals of physics and instrumentation to arrive at solution for various problems.
LO2	To study the application aspects of the experiments
LO3	To understand the usage of basic laws and theories to determine various physical properties of the given materials.
LO4	To provide hands-on learning experience and applications of microcontroller.

Course Outcomes (CO):

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

CO1	understand the basic laws and theories regarding the various physical properties of the materials
CO2	understand the given concepts and its physical significance
CO3	apply the theory to design the basic electronic circuits
CO4	provide hands-on learning experience and applications of microcontroller.

(**Any Sixteen experiments**)

1. Spectrophotometer
2. Co-effeicient of linear expansion-Interference Method.
3. Dipole moment of Liquids - R.F. Oscillator
4. Susceptibility of Salt solutions/Solids-Guoy method
5. Susceptibility of liquid mixture - Calculation of Bohr magneton using Quincke's method.
6. Phase diagram - Two component system.
7. Molecular constants – AIO Band
8. Molecular constants - CN Band.
9. Cu-Salt spectrum - ultra violet region.
10. Optical rotation of quartz.
11. Absorption co-efficient of a Al foil - G.M. Counter
12. F.P. Etalon.
13. Dielectric of Solids
14. Determination of pH for liquids – various concentration / temperature .
15. Stark Effect
16. ESR experiment
17. Micro hardness of a Crystal
18. Micro controller 8051 - Setting and Masking bits in an 8-bit number.
19. Microcontroller 8051 - Generate a delay.
20. Microcontroller 8051 - DAC interfacing.
21. Microcontroller 8051 – Display and Rolling of messages.

COURSE OUTCOME MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	3	3	3	3	3	2	3		1	3	2		3		3	3	3
CO2	3	3	3	3	3	3	2	3		1	3	2		3		3	3	3
CO3	3	3	3	3	3	3	3	3		3	3	3		3		3	3	3
CO4	3	3	3	3	3	3	3	3		3	3	3		3		3	3	3

Note : 3 - Strong, 2 - Medium, 1 - Low

DEPARTMENT ELECTIVE COURSES

Semester	19PHYE205 - MICROPROCESSORS AND MICROCONTROLLER	L	T	P	C
II		3	0	0	3

Learning Objectives (LO):

LO1	To learn the architecture of 8085 microprocessor and its programming.
LO2	To study the architecture of 8086 microprocessor.
LO3	To familiarize the architecture of 8051 microcontroller and its programming
LO4	To study the interfacing devices of microprocessor 8085.

Course Outcomes (CO)

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

CO1	describe basic concept and architecture of 8085 microprocessor and implement programs in 8085.
CO2	learn the architecture of 8086 microprocessor.
CO3	understand the architecture of 8051 microcontroller and develop assembly language programs.
CO4	discuss concept of interfacing in microprocessor 8085.

UNIT– I: MICROPROCESSORS 8085 ARCHITECTURE

Intel 8085 microprocessor: Introduction – Pin configuration - Architecture and its operations - Machine cycles of 8085. Interfacing of memory and I/O devices. Instruction classification: number of bytes, nature of operations - Instruction format. Vectored and non - vectored interrupts.

UNIT– II: 8085 ASSEMBLY LANGUAGE PROGRAMMING

Instruction set: Data transfer operations - Arithmetic operations Logical operations – Branching and machine control operations. Addressing modes. Writing assembly language programs: Looping, counting and indexing. Counters and time delays - Stack - subroutine. Translation from assembly language to machine language

UNIT– III: MICROPROCESSOR 8086

Intel 8086 microprocessor: Introduction – Architecture - Pin configuration - Operating modes: Minimum mode, Maximum mode. Memory addressing: 8-bit data from even and odd address bank, 16-bit data from even and odd address bank. Addressing modes. Interrupts: Hardware interrupts – Software interrupts –Interrupt priorities. Simple programs

UNIT– IV: MICROCONTROLLER 8051 ARCHITECTURE AND PROGRAMMING

Introduction to microcontroller and embedded system. Difference between microprocessor and microcontroller. 8051 microcontroller : Pin configuration, Architecture and Key features. 8051. Data types and directives Instruction set: Data transfer instructions - Arithmetic instructions – Logical instructions- Branching instructions- Single bit instructions. Addressing modes. Simple programs using 8051 instruction set.

UNIT– V: INTERFACING OF MICROPROCESSOR 8085

Basic concepts of programmable device - 8255 Programmable Peripheral Interface (PPI) – interface of ADC and DAC. 8257 Direct Memory Access (DMA) controller. Basic concepts of serial I/O and data communication – interface of 8251 Universal Synchronous Asynchronous Receiver Transmitter (USART)

CURRENT STREAMS OF THOUGHT (Not for Final Examinations)

GENERATION OF PROCESSORS

Introduction to core i5, core i7 and core i9 processors - salient features - comparison of 7^{th} and 8^{th} generation processors – introduction to mobile processors (single, dual, quad and hexa core).

TEXT BOOKS:

1. Ramesh S. Gaonkar, (2013), *Microprocessor Architecture, Programming and Applications with 8085/8080*, New Age International 6^{th} edition.
2. Kenneth J. Ayala, (2000), *The 8051 Microcontroller Architecture, Programming and Applications*, Penram International publishing Pvt. Ltd., second edition.
3. Muhammad Ali Mazidi and Janice Mazidi, (2000), *The 8051 Microcontroller and Embedded systems*, Pearson Education.

SUPPLEMENTARY READING:

1. Godse A.P and D.A.Godse, (2009), *Microprocessors and Microcontrollers*, Technical Publications, Pune.
2. Badri Ram, (2001), *Advanced Microprocessors and Interfacing*, Tata McGraw Hill.
3. Douglas, V, (1993), *Microprocessors and Interfacing-Programming and Hardware*, Hall, Tata McGraw Hill.

COURSE OUTCOME MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	3	3	3	3	3	3	3	1	3	3	3		3			3	3
CO2	3	3	3	3	3	3	3	3	1	3	3	3		3			3	3
CO3	3	3	3	3	3	3	3	3	1	3	3	3		3			3	3
CO4	3	3	3	3	3	3	3	3	1	3	3	3		3			3	3

Note : 3 - Strong, 2 - Medium, 1 – Low

Semester	19PHYE206 - PHYSICS OF THE EARTH	L	T	P	C
II		3	0	0	3

Learning Objectives (LO):

LO1	To highlight the concept of solar system and behaviour of planets in this system.
LO2	To study the elastic behaviour in earth by applying various theories and hypothesis.
LO3	To understand the physical structure and behaviour of the earth as well as geomagnetic properties of rocks in the Earth's crust.

Course Outcomes (CO)

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

CO1	think and analyse the concept of the earth and its properties.
CO2	accumulate the various concepts proposed by theories and laws.
CO3	enlighten the concept solar system.
CO4	acquire basic knowledge about geomagnetism and palaeomagnetism.

UNIT –I: SOLAR SYSTEM

The earth and the solar system – Important physical parameters and properties of the planet earth; Stress and Strain, Wave and motion, Seismic waves. Travel time Tables and Velocity – Depth curves – Variation of Density within the Earth.

UNIT – II: GRAVITATION

Rotation of the Earth - Gravitational attraction, Gravitational Theory, Measurements of Gravity, Gravity meters - Principles and method of measuring gravity - Gravity anomalies-Local and regional variations.

UNIT – III: THERMAL HISTORY OF EARTH

Thermal history of the Earth. Temperature in the Primitive Earth and the Earth's surface and interior. Thermal conductivity. Generation of heat in the Earth. Heat flow measurements, methods and results.

UNIT – IV: ELASTIC PROPERTIES

Elastic constants and Elastic process in the earth. Earth's free rotation. Latitude variation. Tides of the Solid earth. Numerical values of Love's numbers. Rigidity of the Earth. Bulk modules in the earth. Poisson's ratio in the Earth, Young's modulus and Lame's constant.

UNIT – V: GEOMAGNETISM AND PALAEOMAGNETISM

Geomagnetism and palaeomagnetism - Earth's magnetic field. Origin - Theory of earth's magnetic field. Magnetohydrodymics of the Earth. Magnetic reversals. Polar wandering. Tectonic movements and its relation to palaeomagnetism - Measurement of magnetic properties of rocks.

CURRENT STREAMS OF THOUGHT (Not for Final Examinations)

Hydrological cycle - origin of groundwater, subsurface distribution of water, springs - Hydrological Properties of Water Bearing Materials - Porosity, void ratio, permeability, transmissivity, storativity, specific yield, specific retention, diffusivity - Mode of occurrence of groundwater, classification of rocks with respect to their water bearing characteristics, aquifers, aquicludes, aquitards - classification of aquifers and groundwater provinces - Physical and chemical characteristics of groundwater, classification of groundwater in respect to domestic, irrigation and industrial use, pollution of groundwater.

BOOKS FOR STUDY:

1. Jacobs, J.A, Russel, R. D, and Wilson J. T, (1974), *Physics and Geology*.
2. Eve, A.S, and Keys, D. A, (2011), *Applied Geophysics*, Cambridge University.
3. William Lowrie, (2007), *Fundamentals of Geophysics*, Cambridge University.

SUPPLEMENTARY READING:

1. Wyllie, P.J, (2019), *The dynamic Earth, John Wiley and Sons*, International Student Edition.
2. Fowler, C.M.R, (1996), *The Solid Earth, An Introduction to Global Geophysics*, Cambridge University press.
3. Alan Cox, (1973), *Geomagnetic Reversals and Plate Tectonics*, Freeman and company.

COURSE OUTCOME MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	3	3	3	3	3	3	3	3	3	3			3		2	2	3
CO2	3	3	3	3	3	3	3	3	3	3	3			3		2	2	3
CO3	3	3	3	3	3	3	3	3	3	3	3			3		2	2	3
CO4	3	3	3	3	3	3	3	3	3	3	3			3		2	2	3

Note : 3 - Strong, 2 - Medium, 1 – Low

Semester	19PHYC207 - ENERGY PHYSICS	L	T	P	C
II		4	0	0	4

Learning Objectives (LO):

LO1	To create an awareness among the students regarding the forms of energy and the availability of their resources

LO2	To educate regarding the utilization and conservation of energy
LO3	To impart a knowledge about the Sustainable forms of energy

Course Outcomes (CO):

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

CO1	identify various forms of energy and recognize the effective utilization of their resources.
CO2	evaluate the practical usage of solar energy.
CO3	describe the practical usage of thermal energy.
CO4	list out and use the sustainable forms of energy.

UNIT– I: CONVENTIONAL ENERGY SOURCES

Energy sources and their availability: Various forms of energy – Renewable and conventional energy systems – Comparison – Coal, oil and natural gas.

UNIT – II: SOLAR ENERGY

Solar Energy: Thermal application and solar radiation – Energy alternatives – Devices for thermal collection and storage – Thermal applications – Water heating – Space heating – Power generation – Instruments for measuring solar radiation and sunshine.

UNIT – III: THERMAL ENERGY STORAGE

General characteristics - Definitions - Methods of classifications - Thermal energy storage - Sensible heat storage - Liquids - Solids – Latent heat storage - Thermochemical storage.

UNIT – IV: PHOTO CONVERSION

Photovoltaic conversion - Principle and working of Solar cells - Conversion efficiency - Single crystal and Polycrystalline silicon - Cadmium sulphide - Cadmium telluride.

UNIT – V: SUSTAINABLE FORMS OF ENERGY

Reserves of Energy Resources – Environmental aspects of energy extraction, conversion and utilization – challenges associated with the non-sustainable energy sources with regard to future supply and the environment.

Hydrogen: Principle of operation and system components – comparisons among energy uses, resources, and technologies – technical and economic challenges in the integration of sustainable energy form – potential solutions and applications.

CURRENT STREAMS OF THOUGHT: (Not for Final Examinations)

WAVE POWER

Introduction – Wave motion – wave energy and power – Real (irregular) sea waves: Patterns and power – Energy extraction using devices: wave power devices – social, economic and environmental aspects.

TEXT BOOKS :

1. Sukhatme Nayak, P, (2017), *Solar Energy*, 4th ed., Tata McGraw-Hill.
2. Kothari, D.P, et al., (2016), *Renewable Energy Sources and Emerging Technologies*, Prentice Hall of India.
3. Rai, G.D., (2011), *Non-conventional Energy Sources*, Khanna Publication.

SUPPLEMENTARY READING:

1. Kreith and Kreider, (2015), *Principles of Solar Engineering*, 3rd ed. McGraw Hill Publication.
2. Meinel, A.B and Meinal, A.P, (1976), *Applied Solar Energy*.
3. John Twidell and Tony Weir, (2016), *Renewable Energy Resources*, 3rd ed., BSP Books Pvt. Ltd.

COURSE OUTCOME MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	3	3	3	3	3	3	3	3	3	3			3		2	2	3
CO2	3	3	3	3	3	3	3	3	3	3	3			3		2	2	3
CO3	3	3	3	3	3	3	3	3	3	3	3			3		2	2	3
CO4	3	3	3	3	3	3	3	3	3	3	3			3		2	2	3

Note : 3 - Strong, 2 - Medium, 1 – Low

Semester	19PHYE305 – INSTRUMENTATION	L	T	P	C
III		3	0	0	3

Learning Objectives (LO):

LO1	To create an awareness about the different types of transducer and their applications
LO2	To impart knowledge about Digital, Analytical and Biomedical instrumentation.
LO3	To educate regarding the functioning of medical imaging instruments.

Course Outcomes (CO) :

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

CO1	select the appropriate type of transducer for measurement of a specific physical parameter.
CO2	test and use the digital instruments for different applications.
CO3	evaluate the potential applications of various analytical and biomedical instruments.
CO4	describe the functioning of medical imaging instruments.

.

UNIT – I: TRANSDUCERS

Basic functional elements of measuring system –Transducers: Definition – Parts – Classification – Types of primary sensing element.

LVDT: Principle – Working – Measurement of displacement.

Electrical Strain Gauge: Principle – Theory-Types – Working – Measurement of Force (or) Pressure.

Capacitive Transducers: Principle – Types – Working – Measurement of linear and angular displacement.

Thermistor: Principle – Working – Measurement of temperature.

Piezo electric transducers: Principle – theory – operation.

UNIT – II: DIGITAL INSTRUMENTATION

Principle, block diagram and operation: Digital Multimeter, Digital Frequency counter, Digital pHmeter, Digital Conductivity meter, Digital Storage Oscilloscope and Q-meter.

UNIT – III: ANALYTICAL INSTRUMENTATION

Principle, working, Instrumentation and applications: UV-VIS Spectrophotometer, ICP-AES (Inductively Coupled Plasma - Atomic Emission Spectrometer), SEM (Scanning Electron Microscope) and AFM (Atomic Force Microscope).

UNIT – IV: BIO-MEDICAL INSTRUMENTATION

Origin of Bio-potentials – Measurements – Resting and Action potentials - Characteristics of resting potential I– Bio electric potentials –Types of bioelectric signal and their characteristics.

Components of the Bio-medical instrument system – Electrodes : Equivalent circuit – theory – types.

Principle, block diagram and functioning of ECG, EEG and EMG.

UNIT – V: MEDICAL IMAGING INSTRUMENTATION

Magnetic Resonance Imaging: Principle – Magnetic resonance phenomena – Magnetic resonance imaging process – Instrumentation.

Ultrasonic Imaging System: Principle – Construction of an ultrasonic transducer - Ultrasonic propagation through tissues – Display: A-mode, B-mode, M-mode or TM mode – Doppler mode – Recording devices.

Computed Tomography: Principle – CAT scanning – Instrumentation – Contrast scale – Scanning components.

CURRENT STREAMS OF THOUGHT (Not for Final Examinations)

MEASUREMENT OF PHYSIOLOGICAL PARAMETERS

Blood Pressure Measurement: Introduction – Direct measurement using Catheters – Advancement of Direct Method - Indirect Method: Oscillometric measurement method.

Electromagnetic Blood Flow Meters – Ultrasonic Blood Flow Meter – transit time method – Doppler effect based ultrasonic blood flow meter – Laser Doppler Blood Flow Meter – NMR Blood Flow Meter.

Digital Thermometer – Digital Thermal Scanner – Digital Pulse Oximeter.

TEXT BOOKS:

1. Sawhney, A.K, (2000), *Electrical and Electronics Measurement and Instrumentation*, Dhanpath Rai and Company Pvt. Ltd.
2. Rajendra Prasad, (2002), *Electronic Measurements and Instrumentation*, Khanna Publishers.
3. Arumugam, M, (2001), *Biomedical Instrumentation*, Anuradha Publishers.

REFERENCE BOOKS :

1. Willard, D. Merrit, et.al, (2004), *Instrumental methods of analysis*, CBS Publishers.
2. Khandpur, R.S, (2007), *Hand Book of Biomedical Instrumentation*, TMH.
3. Venkata Ram, S.K, (2001), *Biomedical Electronics and Instrumentation*, Galgotia Publications Pvt. Ltd.

COURSE OUTCOME MAPPING:

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

Note : 3 - Strong, 2 - Medium, 1 – Low

Semester	19PHYE306 - BIO-MEDICAL INSTRUMENTATION	L	T	P	C
III		3	0	0	3

Learning Objectives (LO):

LO1	To gain the knowledge about the bio medical instruments used for measuring bio-electric potentials and the electrodes used for sensing the bio-potentials.
LO2	To understand the working principles of imaging equipments and bio medical instruments used for determining the physiological parameters.
LO3	To update the knowledge of various lasers used for medical applications for the students.

Course Outcomes (CO)

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

CO1	understand the importance of bio medical instruments and accuracy of the measured physical parameters and their practical implementation in the medical field.
CO2	understand experimentally recording data, its inference to diagnose the diseases.
CO3	understand various techniques and its relevance in various defects in the body parts.
CO4	solve the health issues from the bio-medical instruments and applicability in physics concepts may give the clear idea about the health issues.

UNIT – I: BIO-ELECTRIC POTENTIALS

Resting and action potentials – Propagation of action potentials – Bioelectric potentials - Electrocardiogram (ECG) – Electroencephalogram (EEG) – Electromyogram (EMG) – Electroretinography (ERG) - Electrooculography (EOG).

UNIT – II: BIO-POTENTIAL ELECTRODES

Biopotential Electrodes – Types of Electrodes - Microelectrodes – Body surface electrodes – Depth and Needle electrodes - Chemical electrodes – Distortion in measured bioelectric signals using electrodes - Electrode paste.

UNIT – III: IMAGING EQUIPMENTS

Ultrasonic Imaging – Reflection - Scattering-A mode display-B mode display - TM mode display - Ultrasonic imaging instrumentation - Biomedical applications - Magnetic Resonance Imaging (MRI) – Principle – Instrumentation - Advantages of MRI over other medical imaging techniques – Thermograph – Endoscopy.

UNIT – IV: MEASUREMENT OF PHYSIOLOGICAL PARAMETERS

Blood Pressure Measurement-Introduction - Direct Measurement using Catheters - Advance of Direct Method - Indirect Method - Oscillometric measurement method.

Electromagnetic Blood Flow Meters - Ultrasonic Blood Flow Meter - transit time method - Doppler effect based ultrasonic blood flow meter - laser Doppler Blood Flow Meter - NMR Blood Flow Meter

UNIT – V: LASER IN MEDICINE

Introduction - Characteristics of laser ligh t- Generation of laser - Components of laser - Types of laser - Nd-YAG laser - Helium-Neon laser - CO_2 laser - Semiconductor laser - Applications of laser in Medical field.

Current streams of Thought (Not for Final Examinations)

BIOTELEMETRY, TELEMEDICINE AND SAFETY MEASUREMENTS

Elements of Biotelemetry system - Design of a biotelemetry system, Implantable Units - Problems, Application of Telemetry in Patient Care - Fundamentals of Telemedicine, Block diagram of Telemedicine - Scope & Benefits and Limitation of Telemedicine.

TEXT BOOKS

1. Rajalakshmi, T, (2008), *Bio Medical Instrumentation*, First Edition, Sams. Publishers.
2. Arumugam, M, (2000), *Biomedical Instrumentation*, Fourth reprint, Anuradha Agencies.
3. Khandpur, R.S, (2007), *Hand book of Biomedical Instrumentation*, Tata McGraw Hill.

SUPPLEMENTARY READING:

1. Robert B Northrop, (2005), *Introduction to Biomedical Instrumentation and Measurements* 2nd edition, LLCCRC Press is an imprint of Taylor & Francis Group.
2. Khandpur, R.S, (2016), *Hand Book of Bio medical Instrumentation*, 3 rd Edn, Access Eng.Tata McGraw Hill
3. Dominique Placko, (2010), *Fundamentals of Instrumentation and Measurement*, by ISTE Ltd. Tata McGraw Hill

COURSE OUTCOME MAPPING:

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

Note : 3 - Strong, 2 - Medium, 1 - Low

Semester	19PHYE307 - PETROPHYSICS	L	T	P	C
III		3	0	0	3

Learning Objectives (LO):

LO1	To understand the various magnetites and behaviour of the remanance properties.
LO2	To study the geomagnetic elements of the earth and various magnetometer instruments.
LO3	To understand the classification and properties of of rock forming minerals
LO4	To highlight the concept of seismic waves and various dating methods.

Course Outcomes (CO):

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

CO1	**u**nderstand the various magnetites and behaviour of the remanance properties.
CO2	study the geomagnetic elements of the earth and various magnetometer instruments.
CO3	understand the classification and properties of of rock forming minerals
CO4	highlight the concept of seismic waves and various dating methods.

UNIT – I:

Magneto crystalline anisotropy – Dipolar anisotropy – Single ion anisotropy – Anisotropic exchange – Constants. Magnetic properties of mineral systems – Solid-Solid – Solution of oxides of iron – magnetite, haematite magnemites, titano magnetites, titono magneites, haematite – illmenite solid solution and pyrhotites – Intrinsic properties, magnetization process, weak field remanance.

Remanance properties - NRM, TRM, CRM, DRM, VRM, PRM – their mechanisms – Thermal demagnetization technique – partial TRM – additive law – Neel's theory of TRM. Primary and Secondary magnetization – Testing for stability of remanance.

UNIT – II:

Geomagnetic elements of the earth – Field variation and detection - The Magnetic observatory – mapping of secular variations. Diurnal variation of magnetic disturbances – initial susceptibility of rocks – single and multidomain cases – Curie point determination and its importance.

Laboratory and field instruments for magnetic measurements – Astatic magnetometer – spinner magnetometer – Fluxgate magnetometer, Proton procession magnetometer – Theory, practice and applications.

UNIT – III:

Classification of rock forming minerals – physical properties of minerals with special reference to optical properties – elementary details of a polarizing microscope and petrographic analysis.

Geophysical prospecting – different methods – Geophysical properties of rocks and minerals – Resistivity methods – Two current electrode method - different electrode layouts – measuring equipment – application to ground water survey.

UNIT – IV:

Seismic waves – S waves & P waves – elastic, plastic behavior of rocks – modulus of elasticity in rocks – Time distance curves and the location of epicenters – Derivation properties from the velocities – the recent developments.

UNIT – V:

Geochronology – the geological time scale – archaeo-magnetic dating – Radio active methods of dating – Rubidium, Strontium method – Potassium Argon method – Thermo-luminescence dating and interpretation of data.

Current streams of Thought (Not for Final Examinations)

Principles and limitations of geophysical exploration methods - Elements of seismic surveying - Electrical surveying - Gravity surveying - Magnetic surveying- Electromagnetic surveying - Radiometric surveying.

TEXT BOOKS:

1. Singhal, RL, (2014), *Solid State Physics,* Kedar Nath Ram Nath & Co. Meerut.
2. Dekker, A.J, (2015), *Solid State Physics*, Prentice Hall.
3. Semana and Gupta and Sexana, (2016), *Solid State Physics*, Pragati Prakash, Meerut.

REFERENECE BOOKS :

1. Howell, (2012), *Introduction to Geophysics*, McGraw Hill Book Co.
2. Garland, G.D, (1981), *Introduction to Geophysics*, Saunder's Book Co., 2^{nd} Edn.
3. Dobrin, (2014), *Introduction to Geophysical prospecting*, McGraw Hill Book Co.

COURSE OUTCOME MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	3	3	3	3	3	3	3	3	3	3			3		2	2	3
CO2	3	3	3	3	3	3	3	3	3	3	3			3		2	2	3
CO3	3	3	3	3	3	3	3	3	3	3	3			3		2	2	3
CO4	3	3	3	3	3	3	3	3	3	3	3			3		2	2	3

Note : 3 - Strong, 2 - Medium, 1 - Low

Semester	19PHYE308 - MEDICAL PHYSICS	L	T	P	C
III		3	0	0	3

Learning Objectives (LO):

LO1	To gain the knowledge about the bio medical instruments used for measuring bio-electric potentials and the electrodes used for sensing the bio potentials.
LO2	To understand the working principles of imaging equipments and bio medical instruments used for determining the physiological parameters.
LO3	To update the knowledge of various nuclear medicine and biological effects of radiation.

Course Outcomes (CO):

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

CO1	gain the knowledge about the bio medical instruments used for measuring bio-electric potentials and the electrodes used for sensing the bio potentials.
CO2	to understand the working principles of imaging equipments used for determining the physiological parameters.
CO3	to understand the working principles of bio medical instruments used for determining the physiological parameters.
CO4	to update the knowledge of various nuclear medicine and biological effects of radiation

UNIT – I: Bio-Electric Potentials

Resting and action potentials - Propagation of action potentials – Bioelectric potentials – Electrocardiogram (ECG) – electroencephalogram (EEG) – Electromyogram (EMG) – Electroetinography – Electrooculography (EOG).

Bio- potential Electrodes – Types of electrodes – Microelectrodes – Body surface electrodes – Depth and Needle electrodes – Chemical electrodes – Distortion in measured bioelectric signals using electrodes – Electrode paste.

UNIT – II: Digital X-ray imaging and Computed Tomography

Production of X-rays – Types of X-ray tubes – Generators – Interaction of X-ray and Gamma rays with matter – Image formation and image quality – CR and DR – the image intensifier – fluoroscopy – Equipment for computed tomography scanning – Image reconstruction – Helical and multi-slice scanning – Image quality and artifacts – CT dose index.

UNIT – III: Imaging with Ultrasound and MRI

Piezoelectric effect – Interference – Different types of transducers – Modes of scanning – Image quality and artifacts – Doppler methods – Hemodynamic data – Spin echo sequence – Spatial encoding – functional MRI – Magnets and coils – Hazards and safe practice – Thermograph – endoscopy.

UNIT – IV: Physics of Nuclear Medicine and Biological effects of Radiation

Radioactivity - Radioactive transformation – Radiopharmaceuticals – Hot lab – Gamma camera – Planner imaging – tomography with radionuclide – PET scanner – Characteristics and quality assurance of images – Precautions necessary in handling open radioactive sources – Ionizing radiation interactions with tissues – Radiation dose and units – Effects of radiation – Principles of radiation protection – ICRP, BARC and AERB – eLORA – Practical aspects of radiation protection.

UNIT – V: Medical Imaging Instrumentation

Radiation therapy – Surgery – Chemotherapy – Hormone therapy – Immunotherpy and Radionuclide therapy – Begin and malignant disease – Methods of spread of malignant disease – Staging and grading systems – Teletherapy and Brachy therapy – Co-60 and other radioactive sources used in the treatment of cancer – Modern treatment techniques – Treatment planning – Non-Photon ionizing radiation treatments and challenges.

Current streams of Thought (Not for Final Examinations)

RADIO NUCLIDE IMAGING

Interaction of nuclear particles and matter, nuclear sources, nuclear radiation detectors, rectilinear scanner, scintillation camera, SPECT, PET, and Gamma ray camera, medical LINAC.

TEXT BOOKS:

1. Rajalakshmi, T, (2012), *Bio Medical Instrumentation*, Second Edition.
2. Arumugam, M, (2014), *Bio Medical Instrumentation*, Anuradha Agencies, Fifth reprint.
3. Khandpur, R.S, (2007, *Handbook of Biomedical Instrumentation*, Tata McGraw Hill.

SUPPLEMENTARY READING:

1. Penelope Allsiy, Rpberts, Jerry R.Villiams, Saunders,Farr's, (2013), *Physics for Medical Imaging*, Elsevier, Third Edition.
2. Fiaz M.Khan, (2006), *The Physics of Radiation Therapy*, Second Edition, Springer.
3. Ramesh Chandra, (2008), *Nuclear Medicine Physics*, Lea and Febiger. 5th Edition.

COURSE OUTCOME MAPPING:

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

Note : 3 - Strong, 2 - Medium, 1 - Low

Semester	19PHYE309 – BIOPHYSICS	L	T	P	C
III		3	0	0	3

Learning Objectives (LO):

LO1	To understand the applications of various microscopic tools in cell biology.
LO2	To understand the fundamentals of macromolecular structure.
LO3	To understand the analytical techniques in characterizing biomolecular interactions and its structure

Course Outcomes (CO):

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

CO1	Have in-depth knowledge of the structure of cells and the macromolecular structure.
CO2	Understand the basic principles of the various microscopic techniques presented in the course, their advantages and limitations
CO3	Provide an introduction to various separation techniques that are used in biological samples.
CO4	Understand the different processes of optical and diffraction techniques.

UNIT – I: CELL ORGANIZATION

Cell as the basic structural unit - Origin & organization of Prokaryotic and Eukaryotic cell - Cell size & shape - Fine structure of Prokaryotic & Eukaryotic cell organization (Bacteria, Cyanobacteria, plant & Animal cell) - Internal architecture of cells - cell organelles - compartment & assemblies membrane system – Ribosome – Polysomes – Lysosomes – Peroxisomes - Connection between cell & its environment - Extracellular Matrix.

UNIT – II: TOOLS IN CELL BIOLOGY

Light microscope - Resolving Power - Phase contrast microscope - Detection of small differences in refractive indices - Interference microscope -Dark field microscope - Polarization microscope - Fluorescence microscope - Cytophotometry methods - Flowcytometry & cell sorting - Electron microscopy - specimen preparation - Scanning Electron Microscopy (SEM) - Transmission Electron Microscopy (TEM - Applications.

UNIT – III: MACROMOLECULAR STRUCTURE

Nucleic acid structure: Chemical structure of the nucleic acid - Conformational possibilities of monomers and polymers - Double helix structure of DNA - Polymorphism of DNA - DNA nanostructures and the structure of transfer RNA.

Proteins structure: Amino acids and the primary structures of proteins – Secondary – Tertiary - Quaternary structure and virus structure.

UNIT – IV: SEPERATION TECHNIQUES

Centrifugation: Principle of centrifugation – Analytical ultracentrifugation – Differential centrifugation – Density gradient centrifugation.

Chromatography: Principles of chromatography – Paper chromatography – Thin layer chromatography (TLC) – Gas liquid chromatography (GLC) – High performance liquid chromatography (HPLC).

Electrophoresis: Principles – Factors affecting the migration of substances – Supporting media in electrophoresis – Gel electrophoresis – Polyacrylamide gel electrophoresis (PAGE) – Sodium dodecyl sulphate polyacrylamide gel electrophoresis (SDS-PAGE).

UNIT – V: OPTICAL & DIFFRACTION TECHNIQUES

Circular Dichroism and optical rotator dispersion - Plane, circular and elliptical polarization of light - Absorption by oriented molecules - Dichroic ratio of proteins and nucleic acids - Circular dichroism (CD) - optical rotatory disperson (ORD) - Relation between CD and ORD - Application of ORD in conformation and interactions of biomolecules.

Crystallization of proteins - preparation of heavy metal derivatives - Patterson synthesis - isomorphous replacement methods - structure factors of centro-symmetric and non-centrosymmetric crystals - General remarks on Protein-Structure determination from X-ray diffraction data - Neutron diffraction - Electron diffraction - Synchrotron diffraction, Application in Biomolecular structural studies.

Current streams of Thought (Not for Final Examinations)

SOME ASPECTS OF NANOTECHNOLOGY

Introduction to Protein-based Nanostructures - Nanomotors - Bacterial (E. coli) and Mammalian (Myosin family) Nanobiosensors - Science of Self assembly - Natural to Artificial Structures - Nanoparticles in Biological Labeling and Cellular Imaging

TEXT BOOKS:

1. Subramanian, M.A, (2015), *Biophysics*, MJP Publishers.
2. Veerakumari, L, (2017), *Bioinstrumentation*, MJP Publishers.
3. Deb, A.C, (2018), *Fundamentals of Biochemistry*, New central book agency.

SUPPLEMENTARY READING:

1. Geoffrey M. Cooper, (2019), *The Cell: A Molecular Approach*, ASM Press.
2. Gautham, N, (2013), *Biophysics*, Vasantha Pattabhi, Narosa Publishing.
3. Mishra, P.S, (2010), *Biophysics*, VK Enterprises.

COURSE OUTCOME MAPPING:

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

Note : 3 - Strong, 2 - Medium, 1 - Low