Annexure: I

Faculty of Science

Department of Physics

Ordinance, Curriculum & Syllabus

Master of Science (Physics)

(2020-21)

Shree Guru Gobind Singh Tricentenary University, Gurugram (Haryana)- 122505, India

SHREE GURU GOBIND SINGH TRICENTENARY (SGT) UNIVERSITY,
BUDHERA, GURUGRAM (HARYANA)
FACULTY OF SCIENCE
MASTER OF SCIENCE [PHYSICS]
ORDINANCE

1. PREAMBLE

The University Grants Commission (UGC) has initiated several measures to bring equity, efficiency and excellence in the Higher Education System of the country. The important measures taken to enhance academic standards and quality in higher education include innovation and improvements in curriculum, teaching-learning (online & offline) process, examination and evaluation systems, besides governance and other matters.

The UGC has formulated various regulations and guidelines from time to time to improve the higher education system and maintain minimum standards and quality across the Higher Educational Institutions (HEIs) in India. The academic reforms recommended by the UGC in the recent past have led to overall improvement in the higher education system.

Department of Physics, Faculty of Science, Shree Guru Gobind Singh Tricentenary University, Gurugram with the aim to enhance academic standards in quality of higher education has adopted the UGC guidelines in its Postgraduate (PG) program (M. Sc. Physics).

The grading system is considered to be better than the conventional marks system and in order to facilitate student mobility across institutions within India and across countries the community grade point average (CGPA) has been introduced in this PG program. The guidelines are as follows:

CHOICE BASED CREDIT SYSTEM (CBCS):

The CBCS provides an opportunity for the students to choose courses from the prescribed pool of courses comprising core, elective, skill and ability enhancement courses. The courses can be evaluated by a uniform grading system in the higher education system. This will benefit the students to move across institutions within India to begin with and across countries. The uniform grading system will also enable potential employers in assessing the performance of the candidates. In order to bring uniformity in the evaluation

system and computation of the Cumulative Grade Point Average (CGPA) based on student's performance in examinations, the UGC has formulated the guidelines to be followed.

Outline of Choice Based Credit System:

a. **Core Course:** A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course.

b. **Elective Course:** Generally, a course which can be chosen from a pool of courses and which may be very specific or specialized or advanced or supportive to the discipline/ subject of study or which provides an extended scope or which enables an exposure to some other discipline/subject/domain or nurtures the candidate's proficiency/skill is called an Elective Course.

   i. **Discipline Specific Elective (DSE) Course**: Elective courses may be offered by the main discipline/subject of study is referred to as Discipline Specific Elective. The University/Institute may also offer discipline related Elective courses of interdisciplinary nature (to be offered by main discipline/subject of study).

   ii. **Dissertation/Project:** An elective course designed to acquire special/advanced knowledge, such as supplement study/support study to a project work, and a candidate studies such a course on his own with an advisory support by a teacher/faculty member is called dissertation/project.

c. **Skill Enhancement Course:** The course based upon the content that leads to Knowledge enhancement.

d. **Ability Enhancement Compulsory Course:** The course based upon the content that leads to the development of a professional of ability.

e. **Open Elective Course:** The course based upon the content that enhances interdisciplinary knowledge

2. **Program Educational Objectives (PEOs):**

i. To set up a broad foundation in Physics leading to critical thinking, scientific learning and problem solving attitude.

ii. To engage in and conduct original research in Physics and interdisciplinary areas.

iii. To train the students in performing and publishing experimental investigations among the scientific communities leading to self-learning, ethical awareness and sustainable development of the society.

iv. To become experts and leaders in the different areas of specialization in Physics.

v. To successfully pursue their career in research, academics, entrepreneurship and industry.

3. Program Outcomes (POs):

On successful completion of the Program, students will have the ability to:

PO 1. Disciplinary Knowledge:

Demonstrate the comprehensive knowledge of both theoretical and experimental Physics in various fields of interest like Physical Physics, Inorganic Physics and Organic Physics.

PO 2. Critical Thinking and Problem Solving:

Develop critical thinking for identifying, analyzing and solving different kinds of theoretical / experimental problems by following scientific approach to knowledge development.

PO 3. Analytical / Scientific Reasoning:

Apply appropriate techniques for the qualitative and quantitative analysis of chemical compounds and explore the scientific reasoning for the obtained results.

PO 4. Research Related Skills:

Plan and write basic Physics research projects while keeping in mind the rules and regulations pertaining to different scientific research project operations.

PO 5. Effective Communication:

Demonstrate the subject knowledge through technical writings as well as oral presentations among the scientific community and society.

PO 6. Social Interaction and Effective Citizenship:

Present the experimental investigations at various technical platforms such as Conferences /Seminars/ Symposia/Workshops and also contribute to the future development of the nation through their Voluntary participation in civic life.

PO 7. Multicultural Competency and Leadership Readiness:

Work effectively either independently or as a team leader while being adaptable to various multicultural professional environments.

PO 8. Ethics:

Develop ethical awareness, exercise empathy and a caring attitude while maintaining professional integrity, honesty and high ethical standards.

PO 9. Environment and Sustainability:

Follow and practice processes leading to safe environment and sustainable development while carrying out activities in the laboratory.

PO 10. Self-directed and Life-long Learning:

Inculcate a habit of self-learning continuously through various online/offline educational platforms for personal academic growth as well as for increasing employment opportunity.

4. **Definitions**

i. **Course** means a unit of teaching / individual subject comprising of Lectures, Tutorials and / or Lab that typically lasts one academic term (semester / year) led by one or more instructors (teachers or professors), and has a fixed roster of students. Each Course shall have an individual Course Code e.g. Quantum Mechanics (theory) and Quantum Mechanics (Lab) to be given separate course codes.

ii. **Credit** means a unit by which course work is measured. One hour of lecture / tutorial is equal to one credit and one hour of lab / workshop / project etc. is equal to half credit.

iii. **Program** means any combination of courses and/or requirements leading to a degree, diploma or certificate e.g. M.Sc. (Physics).

iv. **Program Structure** means listing of various courses of a program and the credits associated with them as L-T-P structure which indicates the number of lecture hours/week, number of tutorial hours/week and number of practical hours/week to be devoted for each course e.g. Statistical Mechanics (3-0-2). This means that this course shall have 3 hours of lecture per week and 4 hours of practical work per week.

v. **Scheme of Study** means the Academic Term wise listing of all the courses along with distribution of their formative and summative assessment criteria, which will be normally offered during the entire Program.

vi. **Semester Grade Point Average (SGPA)** means the ratio of sum of the product of the number of credits with the numerical grade scored by a student in all the courses taken by a student in a particular Semester and the sum of the number of credits of all the Courses undergone by a student, i.e. $SGPA(Si) = \sum (Ci \times Gi) / \sum Ci$.

vii. **Cumulative Grade Point Average (CGPA)** means the ratio of sum of the product of the number of credits with the numerical grade scored by a student in all the courses

taken by a student in all Semesters and the sum of the number of credits of all the Courses undergone by a student i.e, CGPA =$\sum$(Ci x Si) / $\sum$Ci.

viii. **Open Elective Course** means a course offered by a Department / Faculty other than the parent Department / Faculty.

5. **Duration and Nomenclature of the Program:**

The duration of M.Sc. Physics program shall be of two academic years consisting of four (04) semesters (16 weeks per semester) under Choice Based Credit System (CBCS). On successful completion of all the four semesters, the student will be awarded M.Sc. Physics degree. The student shall complete the program within a maximum period of 4 years from the date of admission to the first semester as per N+2 rule by UGC (where N stands for minimum duration years of the program). However, in exceptional circumstances a further extension of one more year may be granted. In such cases, permission from competent authorities of the University is mandatory, failing which he/she will be disqualified from the program.

6. **Eligibility criteria for Admission in a Program**

For admission to the 1st Semester of M.Sc. (Physics) program, the candidate must have passed B.Sc. (Pass) with Physics as one of the subjects/B.Sc. (Hons.) Physics with 50% marks (45% marks in case of SC/ST candidates of Haryana only) in aggregate or equivalent grade from any university recognized by UGC.

7. **Registration of Courses at the start of an academic term**

Every student admitted in a Program shall be required to register various courses which he/she needs to undergo in a particular Semester as per the approved Scheme of Study applicable to M.Sc. Physics Program in the prescribed format within the defined timelines.

8. **Medium of Instructions:**

The medium of the instructions for all Programs shall be English only.

9. **Scheme of Study and Syllabi**

(i) Scheme of Study and Syllabi shall be governed by the UGC regulations.

(ii) In M.Sc. Physics, formal classes / labs shall be held for 5 days in a week i.e. Monday to Friday and Saturday shall be reserved for Professional Activities (Curricular / Co-curricular and Extra-Curricular).

(iii) Minimum number of Credits required to earn M.Sc. Physics degree shall be 82 credits.

(iv) Provision has been made in the Scheme of Study for students to earn up to three credits in each Semester through online MOOC courses on the specified portals.
For example, a student may enroll in the courses offered on SWAYAM platform of the Government of India (https://swayam.gov.in/). The courses offered on SWAYAM on SWAYAM portal are offered by the top ranked Universities / Institutions of National Importance spanning 4-12 weeks in higher education domain. A 4-week, 8 week and 12 or more week courses may have 1, 2 & 3 credits respectively. The credits will be accepted if the student appears in the term end examination conducted by the host institution and earns credits for the same with appropriate grade. Similarly, other such platforms may be identified by the department time to time.

(v) For Open Elective Course, a slot of one hour (preferably last lecture) during first three days of the week (Monday to Wednesday) for the whole semester will be earmarked in the time table.

(vi) The syllabus of various theory courses has been designed and distributed in four units and is balanced in terms of Academic workload (e.g. the syllabus has been designed in such a way that the entire theory syllabus is to be covered in 11C hours where C means number of credits per week. 2C/3C hours shall be utilized for discussing performance of the students in class test/assignment and covering currently relevant topics related to the subject).

(vii) The weightage of continuous/ formative evaluation and term-end/ summative evaluation for theory classesis in the ratio of 40 and 60 respectively. Every course has 100 marks for evaluation.

(viii) Continuous/ Formative Evaluation of theory coursesis done in following manner:

a) Mid Semester Examination (Subjective/Objective, Average of two) : 20 Marks
b) Assignments (Average of two) : 10 Marks
c) Professional Activities (Problems/Projects/Seminars/Case Study etc.) : 10 Marks

(ix) A student will be required to register for Professional Activities in the very beginning of the Academic Term (semester) which will be open ended and consists of curricular / co-curricular / extra-curricular activities. Such activities will include extra projects beyond syllabus (SGTU Synergy / Competitive Projects such as Hackathon /

Robocon /BAJA/ SAE etc.), extension and activities related to clubs / societies / chapters of professional bodies / NSS / NCC / Sports etc. Each such activity shall be undertaken by the student under the supervision of a Faculty Member who will keep records of the activity undertaken by the student. Faculty Mentor concerned shall be informed about all the activities being undertaken by every student. Each student shall maintain a diary / log book of activities perform by her/him which will be countersigned by the Faculty Activity in-charge on fortnightly basis. Three weeks before the last day of classes, every student shall submit a portfolio of activities performed by him/her along with diaries / log books to the Faculty Mentor concerned. Head of the Department concerned shall constitute a Portfolio Evaluation Committee consisting of two Faculty members of the Department and a representative of Dean Student Welfare. Portfolio Evaluation Committee shall evaluate the performance of each student separately and award marks on scale of 0 to 10 based upon the efforts put by each student and the outcomes. Portfolio Evaluation Committee shall submit the evaluation report to the Head of the Department concerned who after satisfying herself/himself about the quality of evaluation shall notify the marks to all the Teachers taking theory classes in that Semester for incorporating marks earmarked for professional activities. Such professional activities shall be undertaken on week days after working hours and Saturdays. This provision / evaluation shall measure the group activities, attitude and behavior of the student.

(x) The weightage of continuous/formative evaluation and term-end/summative evaluation of lab classes/summer training/project work are in the ratio of 60 and 40 respectively. Every lab course has 100 marks for evaluation.

(xi) Continuous/Formative Evaluation of lab coursesis done in following manner: -

a)	Attendance and Regularity in Lab Work	:	10 Marks
b)	Lab/Project Work Report	:	10 Marks
c)	Mid Term Oral Exam./ Assessment	:	10 Marks
d)	Conduct/ Demonstration	:	30 Marks

The distribution of formative (internal) assessment marks for the summer training and project work to be kept in-line with the above.

10. Teacher Diary and Course File

(i) Every faculty member should maintain a separate Teacher Diary and a Course file for each course including lab courses.

(ii) Teacher Diary will be maintained in the pre-printed booklet issued from the university store which consists of Index, Syllabus (Theory and Lab), Subject Time Table, Course plan, Daily Diary (Course Coverage), Attendance Record, Evaluation (Internal Assessment) Record, List of Low Performing Students, Value Added Lecture Plan, Internal Practical (Continuous Evaluation) marks for laboratory, Parent Teacher Meeting Record etc.

(iii) Each course file shall contain the following:

- Syllabus
- Learning Resources prescribed
- Tutorial Sheets / Assignments
- Current and Previous Class Test / Sessional Question Papers
- Previous Term-End Examination Question Papers
- Lecture Notes (In the Current file only).

(iv) At the end of the semester, faculty member should submit Teacher Diary and Course File to HODs. HODs shall maintain the record of all course files for at least 5 years.

(v) Faculty member can withdraw his or her handwritten notes from the course file before submitting to HODs.

(vi) In case, Faculty member is allotted same subject in the next semester, then he/she can take same course file from Principal / HODs for few days for the reference purpose only.

11. Home Assignments

a) Home Assignment will be designed as per the final examination pattern as per the details given in the table.

	No of Questions per Assignment

		1 Mark	2 Marks	4 Marks		6 Marks	10 Marks	12 Marks	Total	Time Per	Total
		Marks	1	2	4	6	10	12			
S.No.	Examination Pattern	No of Assignments	2.5	6	10	15	25	30			
1	Pattern	Two per course / One per two units	10	10	5	3	0	0	68	180	12.0

b) Minimum one home assignment shall be given from every two units.

Penalty for late submission of Home Assignment

a) Every Home Assignment shall have the Date of Release and last Date of Submission.

b) Penalty for late submission for Home Assignment in the form of %age of marks deduction shall be as under:

- Within 7 Calendar days: 20%
- Within 8 to 15 Calendar days: 40%
- More than 15 Calendar days: 50%

c) Teachers will ensure that there is no plagiarism in Home Assignment. If plagiarism is detected, a penalty of 30% may be levied and the student will be asked to re-submit the Home Assignment within 7 Calendar days.

12. Question Banking and Question Paper Setting for Term End Examination

(i) Question Banking for Term End Evaluation and home assignments shall be done with questions having 1, 2, 4 and 6 marks. The time allotted to each question shall be as under: -

Description	Marks			
	1	2	4	6
Term End Examination is	2.5 minutes	5 minutes	10 minutes	15 minutes

for 60 marks				

(ii) Each question shall be set in the following format: -

S. No.	Question	Marks Allotted	Time Allotted	Bloom Taxonomy (Cognitive Domain) Level	Difficulty Level	Course Outcome Number

(iii) Bloom Taxonomy (Cognitive Domain) levels shall be: Knowledge, Comprehension, Application, Analysis, Evaluation and Synthesis.

(iv) Difficulty levels shall be: Easy, Moderate and Difficult.

(v) Course Outcome Number shall be the number of specific outcomes given in the Course Objective and Course Outcome Matrix.

(vi) Term-End Examination question papers shall be set for all courses as per pattern given in the following table:

Question Paper Setting											
			No of Questions per subject								
			1 Mark	2 Marks	4 Marks	6 Marks	10 Marks	12 Marks	Case Study	Maximum Marks	Total Time (mins)
S.No.	Examination Pattern	Marks	1	2	4	6	10	12	40		
		No of Units↓/ Time→	2.5	5	10	15	25	30	NA		
1	Pattern	4	12	4	4	4	0	0	NA	60	150.0

Guidelines

a. Duration of end term theory examination: 3 hours.

b. Maximum marks: 60.

c. All Questions shall be compulsory.

d. The Question paper will be divided into four sections A, B, C and D.

e. Section A is compulsory and comprises of 12 questions of one mark each, 3 from each unit. The questions shall be asked in such a manner that there are no direct answers including one word answer, fill in the blanks or multiple choice questions (2.5 minutes each)

f. Section B comprises of 4 questions of 2 marks each, one from each unit. (5 minutes each)

g. Section C Comprises of 4 questions of 4 marks each, one from each unit. (10 minutes each). Each question may have two alternatives, out of which student will be required to attempt one.

h. Section D Comprises of 4 questions of 6 marks each, one from each unit. (15 minutes each). Each question may have two alternatives, out of which student will be required to attempt one.

i. The questions shall be set in such a manner that these cover first five level of Bloom Taxonomy i.e. Knowledge (10-15%), Comprehension (15-25%), Application (15-25%), Analysis (15-25%) and Synthesis (10-15% in normal papers; 50-80% in design papers).

j. The questions shall have three difficulty level namely Easy, Moderate and Difficult with ratio of 1:2:1 respectively.

k. Each question will be linked with the relevant CO.

13. Examination Scheme for Class Test / Sessional Question Papers

(i) Mid Semester Question Papers/ Class Test shall be held normally in 7^{th} and 13^{th} weeks in the semester. Question papers shall be set from minimum 2 units (50% syllabus of each course). Duration shall be 90 minutes. Maximum marks shall be 30.

(ii) The structure of the sessional question papers shall remain the same as in term-end examination question paper.

14. Attendance Requirements/Eligibility to Appear in Term End Examination

(i) A student should have minimum 75% attendance in each Course to be eligible to appear in Term End Examination failing which she/he shall be detained from appearing in the Term End Examination of that particular Course. A maximum condonation to the extent of 10% may be granted by the Dean of Faculty of Science based upon genuine reasons such as hospitalization of self / parents / siblings, death in

the family, participation in University sponsored activities outside the University campus and voluntary blood donation etc.

(ii) It will be the responsibility of the student to keep a track of her/his attendance in each Course in an Academic Term (semester) through ERP Portal and / or Course Teacher.

(iii) If a student is detained in a particular case, she/he shall be required to make-up the deficiency of attendance in the subsequent Academic Terms by attending classes, appearing in class tests and submitting additional home assignments. Once such student has made-up the deficiency, she/he will be allowed to appear in the next supplementary examination.

(iv) If the deficiency is more than 25% in a particular Course (having less than 50% attendance), the student will be required to pay additional fee specified by the university time to time for attending the classes again for which she/he will have to register for the Course(s) again in the subsequent term with the approval of the HOD/Dean concerned.

15. Term End Examination Rules

i. The Term End examination for all semesters shall ordinarily be held in the month of December and May/June for all regular and reappear candidates. The examination dates are fixed by the Controller of Examination with the approval of Vice Chancellor.

ii. Examination Rules including appointment of Examiners, Evaluation of answer sheets, compilation of results, calculation of SGPA/CGPA etc. shall be notified separately.

iii. Answer sheets for the Term End Examination shall be shown to the Examinees before compilation of result by the Faculty members as per schedule (normally in two parts) notified by Head of the Department concerned in consultation with the Controller of Examination.

iv. Normally the schedule for showing answer sheets to the examinees shall be so prepared that they are shown bulk of the answer sheets before last regular examination. Answer sheets related to last two/three exams can be shown within a week from the last date of examination.

v. If a student raises objection to the award of marks in a particular answer sheet, the same shall be considered by a Committee of two Faculty members appointed by Head

of the Department and settled on the same day with the approval of Head of the Department concerned.

vi. No request for re-evaluation of answer sheets shall be entertained after the declaration of results.

16. Project / Dissertation

i. Topic Selection and Appointment of Guide/Supervisor: - Normally selection of project topic / research problem shall be finalized in the previous Semester. HOD concerned shall call applications for allotment of project topic / research problem from the students minimum six weeks before the last date of classes in the previous Semester along with a detailed proposal in the specified format.\

ii. HOD concerned shall constitute a Committee for allotment of project topic / research problem for dissertation consisting of minimum 3 Faculty members. The Committee will interview each student and submit the proposed project topic/research problem for each student along-with the suitable Project / Research Supervisor name. HOD shall approve the recommendation of the committee after satisfying herself/himself about the project topic, research problem and the recommended Supervisor. In case, a Project requires a team activity in an undergraduate program, project team shall not have more-than 3 members and role of each team member shall be well defined.

iii. Student shall start working on the literature review in the previous Semester itself and start the project / research activities right from day-1 of the Academic Term in which the Project / Dissertation is included in the Scheme of Study.

iv. It will be mandatory for each student to publish/write at-least one review / research paper in SCOPUS / Web of Science indexed Journal to become eligible for the award of postgraduate degree. For the purpose of eligibility for the award of degree acceptance by the Journal will be sufficient.

v. Each student/team, as the case may be, shall submit minimum 3 copies of Project Report/ Dissertation in the specified format.

vi. Evaluation of Project/ Dissertation: A project/ dissertation undertaken by students shall be evaluated by a panel consisting of one external and one internal examiner. External examiner shall be appointed by the Dean of Faculty concerned out of the panel approved by the Vice Chancellor.

17. Internship / Field Training

The duration of the Internship will be 4 weeks of 4 credits. The formative and summative assessment marks are mentioned in the scheme of study. The final viva voce and reports will be adjudged by the joint Board of External and/or Internal Examiners.

18. Setting of Question Papers:

i. The Head of the Department/Dean of the Faculty shall supply the panel of internal and external examiners duly approved by the Board of Studies to the Controller of Examinations. The paper(s) will be set by the examiner(s) nominated by the Vice-Chancellor from the panel of examiners.

ii. An examiner shall be allowed to set not more than two papers in a semester examination.

iii. The examiner(s) will set the question papers as per criteria laid down in the Scheme of Examinations as approved by the Board of Studies/Academic Council of the University.

19. Evaluation Process – Theory and Practical:

i. **Evaluation of Answer Books:**

The answer books may be evaluated either by the paper setter or any other internal or external examiner to be nominated by the Controller of Examiners with the approval of the Vice-Chancellor from the panel of examiners approved by the Board of Studies.

ii. **Fail/ Reappear candidates:**

Fail / Re-appear (Internal/External) candidate of any semestermay appear in the re-appear exams, as an ex-student,during any term end exams of his/her remaining semesters and up to two years after his final semester as per N+2 rule.

iii. **Practical Examinations - Appointment of Examiner:**

The practical examinations shall be conducted by a Board of two Examiners consisting of one internal and one external examiner to be nominated by the Vice-Chancellor from the panel of examiners.

iv. **Marks Distribution:**

The distribution of marks in examination of the practical course will be as per the criteria given below:

a. Demonstration/Conduct/Presentation = 50% marks

b. Viva-Voce Examination = 50% marks

20. Evaluation and Gradation Criteria

Evaluation and Gradation Criteria for Continuous / Formative Assessment and Term End / Summative Assessment shall be followed as mention below:

(i) Minimum pass percentage will be 40% for Continuous/Formative Assessment and 40% for Term End/Summative Assessment respectively in all Theory/Practical Courses, making overall minimum pass percentage to be 40%.

(ii) If a student fails to obtain minimum 40% marks in Continuous/Formative Assessment in a Theory paper, he/she will be required to improve the same by appearing in additional class tests and submitting additional assignments before the close of the Academic term. Such students will be allowed to appear in the Term End Examination of that particular Course provided he/she meets the minimum attendance criteria. However, If a student fails to meet the minimum requirement of 40% marks in Continuous/Formative Assessment before the Term End Exams, his/her result in that course will be shown as RL (FCA), in which case he/she will be required to obtain minimum 40% marks in Continuous/Formative Assessment by appearing in additional class tests and submitting additional assignments in subsequent terms.

(iii) If a student fails to obtain minimum 50% marks in Continuous / Formative Assessment in a Theory paper, she/he will be required to improve the same by appearing in additional class tests and submitting additional assignments before the close of the Academic Session. If a student still fails to meet the minimum requirement of 50% marks in Continuous / Formative Assessment, her/his result in that course will be shown as RL (FCA), in which case she/he will be required to obtain minimum 50% marks in Continuous / Formative Assessment by appearing in additional class tests and submitting additional assignments in subsequent Terms. Such students will be allowed to appear in the Term End Examination of that particular Course provided she/he meets the minimum criteria.

(iv) The Letter and Numerical Grades for different range of percentage of marks obtained in Continuous and Term End Assessment together in a particular Course shall be as under:-

Percentage of Marks Obtained	Letter Grade	Numerical Grade	Performance Level
90% and above	O	10	Outstanding
80% and above but less than 90%	A+	9	Excellent
70% and above but less than 80%	A	8	Very Good
60% and above but less than 70%	B+	7	Good
50% and above but less than 60%	B	6	Above Average
Above 40% but less than 50%	C	5	Average
Minimum Pass Marks 40%	D	4	Pass
Below 40%	F	0	Fail

(v) If it is required to calculate the percentage of marks obtained by a student for the entire Program, the same will be calculated by multiplying overall CGPA with a factor of 10.

(vi) Grace marks of maximum 1% of the Theory courses may be permitted in a particular Semester.

21. Declaration of Results:

i. The Controller of Examinations shall declare the results as early as possible after the conclusion of each examination, but before the start of teaching for the next academic session.

ii. Each successful student/ the student placed in reappear shall receive a copy of the Detailed Marks Certificate/ Grade Card Sheet of each semester examination.

iii. The student whose result is declared late without any fault on his/her part may attend classes for the next higher semester provisionally at his /her own risk and responsibility, subject to his /her passing the concerned semester examination. In case, the student fails to pass the concerned semester examination, his/her

attendance/internal assessment in the next higher semester in which he / she was allowed to attend classes provisionally will stand cancelled.

22. Criteria for Promotion to Higher Semester(s):

All students shall be promoted to the next semester / year irrespective of the number of papers cleared/passed in the lower semesters.

23. Improvement of Division after the award of Degree

(i) A student may re-appear for improvement in not more than 5 theory papers only after award of degree within one year from the date of declaration of result of the last / final examination to improve his/her Division after depositing the prescribed Examination Fee as notified by the University from time to time.

(ii) In the case of re-appearance in paper, the result will be prepared on the basis of the candidate's best performance in either of the Examination.

24. Striking off the name of the defaulting students from the rolls of the University

(i) If a student remains absent for a continuous period of seven working days without written authorization from the Head of the Department of concerned, her/his name shall be struck off from the rolls of the University. However, such students may be re-admitted on payment of the Re-admission fee as prescribed by the University from time to time; if Dean/Principal is satisfied that re-admission of the student will not fall short of requisite percentage of the attendance.

(ii) If a student fails to pay fees by the last cut of date as prescribed by the University from time to time, her/his name shall be struck off from the rolls of the University. However, such students may be re-admitted on payment of the Re-admission fee as prescribed by the University from time to time; if Dean/Principal is satisfied that re-admission of the student will not fall short of requisite percentage of the attendance.

(iii) If a student is re-admitted, all his previous records shall be revived under the current structure, regulations and schedule of fees.

25. Other Provisions:

i. Nothing in the Ordinance shall debar the University from amending the Ordinance and the same shall be applicable to all the students whether old or new.

ii. Any other provision not contained in the Ordinance shall be governed by the rules and regulations framed by the University from time to time.

iii. In case of any dispute, the Vice-Chancellor will be competent authority to interpret the rules and his interpretation shall be final.

M.Sc. Physics
Syllabus (2020-21)
Program Structure under Choice Based Credit System (CBCS)

SEMESTER	COURSECODE	COURSENAME	L	T	P	Contact hours/ week	Credits	Max. Marks	Formative Assessment	Summative Assessment
I	**Core Courses (CC)**									
	17080101	Mathematical Physics	3	0	0	3	3	100	40	60
	17080102	Mathematical Physics Lab	0	0	4	4	2	100	60	40
	17080103	Classical Mechanics	3	0	0	3	3	100	40	60
	17080104	Classical Mechanics lab	0	0	4	4	2	100	60	40
	17080105	Statistical Mechanics	3	0	0	3	3	100	40	60
	17080106	Statistical Mechanics Lab	0	0	4	4	2	100	60	40
	Ability Enhancement Compulsory Course (AECC)									
	17080107	Professional Ethics & Human Values	2	0	0	2	2	100	40	60
	Skill Enhance Course									
	17080108	Computational Methods & Programming (Matlab/Python)	2	0	0	2	2	100	40	60
Total Credits			**13**	**0**	**12**	**25**	**19**	**800**	**380**	**420**
II	**Core Courses**									
	17080201	Quantum Mechanics	3	0	0	3	3	100	40	60
	17080202	Quantum Mechanics Lab	0	0	4	4	2	100	60	40
	17080203	Electrodynamics and Plasma Physics	3	0	0	3	3	100	40	60
	17080204	Electrodynamics and Plasma Physics Lab	0	0	4	4	2	100	60	40
	17080205	Atomic and Molecular Physics	3	0	0	3	3	100	40	60
	17080206	Atomic and Molecular Physics Lab	0	0	4	4	2	100	60	40
	Ability Enhancement Compulsory Course (AECC)									
	17080207	Research Methodology	2	0	0	2	2	100	40	60
	Skill Enhancement Course (SEC-3)									
	17080208	The Physics of Nano Materials	2	0	0	2	2	100	40	60
Total Credits			**13**	**0**	**12**	**25**	**19**	**800**	**380**	**420**
	17080209	**Summer Training (4/6 weeks)**	-	-	-	-	**4**	**200**	**100**	**100**
III	**Specialization**									
	Discipline Specific Elective Courses (DSEC)									
		DSEC-I	3	0	0	3	3	100	40	60
		DSEC-I Lab	0	0	4	4	2	100	60	40
		DSEC-II	3	0	0	3	3	100	40	60
		DSEC-II Lab	0	0	4	4	2	100	60	40
		DSEC-III	3	0	0	3	3	100	40	60
		DSEC-III Lab	0	0	4	4	2	100	60	40
	Skill Enhancement Course (SEC-3) (Common for all the specializations)									
	17080301	Laser and its applications	2	0	0	2	2	100	40	60
	Open Elective Course (From University Basket) (Common for all the specializations)									
	17080302	OEC	3	0	0	3	3	100	40	60
Total Credits			**14**	**0**	**12**	**26**	**20**	**800**	**380**	**420**
IV	**In the fourth semester, there are two options. Students may opt for any one**									
	Option-I									
	17080401	*Project Work	0	0	20	20	20	800	400	400

Option-II (Students may opt any four courses along with their labs except the course of specialization)										
	17080402	Electronics	4	0	0	4	4	100	40	60
	17080403	Electronics- lab	0	0	2	2	1	100	60	40
	17080404	Condensed Matter Physics: Basics	4	0	0	4	4	100	40	60
	17080405	Condensed Matter Physics: Basics-Lab	0	0	2	2	1	100	60	40
	17080406	Introductory Nuclear Physics	4	0	0	4	4	100	40	60
	17080407	Introductory Nuclear Physics-Lab	0	0	2	2	1	100	60	40
	17080408	Advance Applied Physics	4	0	0	4	4	100	40	60
	17080409	Advance Applied Physics-Lab	0	0	2	2	1	100	60	40
	17080410	Spectroscopic Techniques	4	0	0	4	4	100	40	60
	17080411	Spectroscopic Techniques-Lab	0	0	2	2	1	100	60	40
Total credits			**16**		**8**	**24**	**20**	**800**	**400**	**400**
Grand Total			**56**	**0**	**56**	**96**	**82**	**3400**	**1640**	**1760**

*Project Work: The project work may be carried out at in-house labs or some outside agency having required facilities for the specified work. On successful completion of the project, every candidate has to submit a final dissertation/report to their concerned department.

Semester (Credits)	Core Courses	DSE Courses	SE Courses	AEC Courses	Research Training/Advance Courses	Open Elective	Total
I	15	-	2	2	-	-	**19**
II	15	-	2	2	-	-	**19**
III	-	15	2	-	-	3	**20**
IV	-		-	-	20	-	**20**
Total	**30**	**15**	**6**	**4**	**20**	**3**	**78**
Summer Training (4/6 Weeks) after second semester							**04**
Online courses from SWYAM (Sem – I to Sem – III) Maximum							**09**
Grand Total							**91**
Minimum Credits for award of degree							**82**

Category	Credits	%
Core Course (CC)	30	40%
Discipline Specific Elective Course (DSEC)	15	17%
Skill Enhancement Course (SEC)	6	7%
Ability Enhancement Compulsory Course (AECC)	4	4%
Research Training	20	22%
Open Elective	3	3%
Summer Training after second semester	4	4%
Online courses from SWYAM (Sem – I to Sem – III)	9	10%
Total	91	

S.No	DSE Courses	Course Code	Course Name
		Electronics	
1	DSEC-I	17080303	Semiconductor Devices
2	DSEC-I Lab	17080304	Semiconductor Devices Lab
3	DSEC-II	17080305	Digital Electronics
4	DSEC-II lab	17080306	Digital Electronics Lab
5	DSEC-III	17080307	Analog and Digital Communication
6	DSEC-III lab	17080308	Analog and Digital Communication Lab
		Condensed Matter Physics	
7	DSEC-I	17080309	Basic Concepts in Condensed Matter Physics
8	DSEC-I Lab	17080310	Basic Concepts in Condensed Matter Physics Lab
9	DSEC-II	17080311	Condensed Matter Physics: Physical Properties
10	DSEC-II lab	17080312	Condensed Matter Physics: Physical Properties Lab
11	DSEC-III	17080313	Advanced Condensed Matter Physics
12	DSEC-III lab	17080314	Advanced Condensed Matter Physics Lab
		Nuclear Physics	
13	DSEC-I	17080315	Nuclear Physics
14	DSEC-I Lab	17080316	Nuclear Physics Lab
15	DSEC-II	17080317	Advanced Nuclear Physics: Structure and Reactions
16	DSEC-II lab	17080318	Advanced Nuclear Physics: Structure and Reactions Lab
17	DSEC-III	17080319	Experimental techniques in Nuclear Physics
18	DSEC-III lab	17080320	Experimental techniques in Nuclear Physics Lab

Name of the Program : M. Sc. (Physics) Session : 2020-21

Scheme of Study

Sr. No.	Semester/ Year	Course Code	Nomenclature	Theory/ Practical	Core/ AECC/ SEC/ DSE/ GE/OE	Lecture	Tutorial	Practical	Credits	Theory							Practical													Overall Maximum Marks	Overall Pass Marks	Whether to be offered under CBCS (Yes/No)	Scheme of Examinations (Theory+Internal +Practical+Oral/ Theory+Internal +Practical/ Theory+Practical)
										Summative Assess		Formative Assessment					Summative Assessment				Formative Assessment												
										Max	Pass	Sessional/Class Test	Assignment	Professional Activities	Max	Pass	Demonstration/Conduct/Presentation		Viva-voce		Max	Pass	Attendance & Regularity in Lab Work	Project/Laboratory Work Report	Midterm Oral Examination/Assessment	Conduct/Demonstration		Max	Pass				
1		17080101	Mathematical Physics	Theory	Core	3	0	0	3	60	24	20	10	10	40	16													100	40	NO	Theory+Internal
2		17080102	Mathematical Physics Lab	Practical	Core	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40	NO	Practical+Internal
3		17080103	Classical Mechanics	Theory	Core	3	0	0	3	60	24	20	10	10	40	16													100	40	NO	Theory+Internal
4		17080104	Classical Mechanics lab	Practical	Core	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40	NO	Practical+Internal
5	I / I	17080105	Statistical Mechanics	Theory	Core	3	0	0	3	60	24	20	10	10	40	16													100	40	NO	Theory+Internal
6		17080106	Statistical Mechanics Lab	Practical	Core	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40	NO	Practical+Internal
7		17080107	Professional Ethics & Human Values	Theory	AECC	2	0	0	2	60	24	20	10	10	40	16													100	40	NO	Theory+Internal
8		17080108	Computational Methods & Programming(Matlab/Python)	Theory	SEC	2	0	0	2	60	24	20	10	10	40	16													100	40	NO	Practical+Internal
9		17080201	Quantum Mechanics	Theory	Core	3	0	0	3	60	24	20	10	10	40	16													100	40	NO	Theory+Internal
10		17080202	Quantum Mechanics Lab	Practical	Core	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40	NO	Practical+Internal
11		17080203	Electrodynamics and Plasma Physics	Theory	Core	3	0	0	3	60	24	20	10	10	40	16													100	40	NO	Theory+Internal
12		17080204	Electrodynamics and Plasma Physics Lab	Practical	Core	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40	NO	Practical+Internal
13	II/I	17080205	Atomic and Molecular Physics	Theory	Core	3	0	0	3	60	24	20	10	10	40	16													100	40	NO	Theory+Internal
14		17080206	Atomic and Molecular Physics Lab	Practical	Core	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40	NO	Practical+Internal
15		17080207	Research Methodology	Theory	AECC	2	0	0	2	60	24	20	10	10	40	16													100	40	NO	Theory+Internal
16		17080208	The Physics of Nano Materials	Theory	SEC	2	0	0	2	60	24	20	10	10	40	16													100	40	NO	Practical+Internal
17		17080209	Summer Training	Practical					4								40	40	80	32	20	20	20	60	120	48	200	80	NO	Practical+Internal
18		17080301	Laser and its applications	Theory	SEC	2	0	0	2	60	24	20	10	10	40	16													100	40	NO	Theory+Internal
19		17080302	Open Elective Course	Theory	OEC	3	0	0	3	60	24	20	10	10	40	16													100	40	NO	Theory+Internal
20		17080303	Semiconductor Devices	Theory	DSEC	3	0	0	3	60	24	20	10	10	40	16													100	40	NO	Theory+Internal
21		17080304	Semiconductor Devices Lab	Practical	DSEC	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40	NO	Practical+Internal
22		17080305	Digital Electronics	Theory	DSEC	3	0	0	3	60	24	20	10	10	40	16													100	40	NO	Theory+Internal
23		17080306	Digital Electronics Lab	Practical	DSEC	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40	NO	Practical+Internal
24		17080307	Analog and Digital Communication	Theory	DSEC	3	0	0	3	60	24	20	10	10	40	16													100	40	NO	Theory+Internal
25		17080308	Analog and Digital Communication Lab	Practical	DSEC	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40	NO	Practical+Internal
26		17080309	Basic Concepts in Condensed Matter Physics	Theory	DSEC	3	0	0	3	60	24	20	10	10	40	16													100	40	NO	Theory+Internal
27		17080310	Basic Concepts in Condensed Matter Physics Lab	Practical	DSEC	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40	NO	Practical+Internal
28	III/II	17080311	Condensed Matter Physics: Physical Properties	Theory	DSEC	3	0	0	3	60	24	20	10	10	40	16													100	40	NO	Theory+Internal
29		17080312	Condensed Matter Physics: Physical Properties Lab	Practical	DSEC	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40	NO	Practical+Internal
30		17080313	Advanced Condensed Matter Physics	Theory	DSEC	3	0	0	3	60	24	20	10	10	40	16													100	40	NO	Theory+Internal
31		17080314	Advanced Condensed Matter Physics Lab	Practical	DSEC	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40	NO	Practical+Internal
32		17080315	Nuclear Physics	Theory	DSEC	3	0	0	3	60	24	20	10	10	40	16													100	40	NO	Theory+Internal
33		17080316	Nuclear Physics Lab	Practical	DSEC	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40	NO	Practical+Internal
34		17080317	Advanced Nuclear Physics : Structure and Reactions	Theory	DSEC	3	0	0	3	60	24	20	10	10	40	16													100	40	NO	Theory+Internal
35		17080318	Advanced Nuclear Physics : Structure and Reactions Lab	Practical	DSEC	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40	NO	Practical+Internal
36		17080319	Experimental techniques in Nuclear Physics	Theory	DSEC	3	0	0	3	60	24	20	10	10	40	16													100	40	NO	Theory+Internal
37		17080320	Experimental techniques in Nuclear Physics Lab	Practical	DSEC	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40	NO	Practical+Internal
38		17080401	Project Work	Practical	RT				20								80	80	160	64	40	40	40	120	240	96	400	160	NO	Practical+Internal
39		17080402	Electronics	Theory	DSEC	4	0	0	4	60	24	20	10	10	40	16													100	40	NO	Theory+Internal
40		17080403	Electronics- lab	Practical	DSEC	0	0	2	1								20	20	40	16	10	10	10	30	60	24	100	40	NO	Practical+Internal
41		17080404	Condensed Matter Physics: Basics	Theory	DSEC	4	0	0	4	60	24	20	10	10	40	16													100	40	NO	Theory+Internal
42		17080405	Condensed Matter Physics: Basics-Lab	Practical	DSEC	0	0	2	1								20	20	40	16	10	10	10	30	60	24	100	40	NO	Practical+Internal
43		17080406	Introductory Nuclear Physics	Theory	DSEC	4	0	0	4	60	24	20	10	10	40	16													100	40	NO	Theory+Internal
44		17080407	Introductory Nuclear Physics-Lab	Practical	DSEC	0	0	2	1								20	20	40	16	10	10	10	30	60	24	100	40	NO	Practical+Internal
45		17080408	Advance Applied Physics	Theory	DSEC	4	0	0	4	60	24	20	10	10	40	16													100	40	NO	Theory+Internal

46		17080409	Advance Applied Physics-Lab	Practical	DSEC	0	0	2	1									20	20	40	16	10	10	10	30	60	24	100	40	NO	Practical+Internal
47		17080410	Spectroscopic Techniques	Theory	DSEC	4	0	0	4	60	24	20	10	10	40	16												100	40	NO	Theory+Internal
48		17080411	Spectroscopic Techniques-Lab	Practical	DSEC	0	0	2	1									20	20	40	16	10	10	10	30	60	24	100	40	NO	Practical+Internal
49			**Online Courses during 1st, 2nd, and 3rd semesters***						**9**																						

*** 4 week course-1 credit, 8 week course-2 credit, 12 week course-3 credit,**
Every semester a student may opt for either
one, 12 week course
one, 4 week course & one, 8 week course
Three, 4 week courses

Core Courses

Semester-I

1. Name of the Department: Physics						
2. Course Name	**Mathematical Physics**	**L**	**T**		**P**	
3. Course Code	17080101	3	0		0	
4. Type of Course (use tick mark)		**Core (√)**	**DSE ()**		**SEC ()**	
5. Prerequisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 40		**Tutorials = 0**	**Practical = 0**			
8. Course Description:						
The course will teach about a variety of mathematical methods which are used in solving problems in physics. These methods include solutions of differential equations, tensors and matrices, and complex variables.						
9. Course Objectives:						
To impart knowledge about various mathematical tools employed to study physics problems.						
10. Course Outcomes (COs):						
Students will have understanding of 1. Various techniques to solve differential equations. 2. How to use special functions in various physics problems. 3. Use complex analysis in solving physical problems. 4. Use the orthogonal polynomials and other special functions; 5. Use Fourier series and integral transformation.						
11. Unit wise detailed content						
Unit-1	**Number of lectures = 10**	**Title of the unit: Vector spaces, Tensors and Matrices**				
Vector spaces: Introduction, Definition of linear vector space, Linear independence, Basis and dimension, Scalar product, Orthonormal basis, Linear operators, Matrices, Orthogonal, Unitary and Hermitian Matrices, Eigen values & Eigen vectors.						
Unit - 2	**Number of lectures = 10**	**Title of the unit: Differential Equations and Special Functions**				
First order equation, Second order equation with variable coefficients, Ordinary point, singular point, Series solution around an ordinary point and regular singular point, Solution of Legendre equation, Solution of Bessel's equation, Hermite & Laguerre equations.						

Unit - 3	Number of lectures = 10	Title of the unit: Complex Variables
Function of complex variable, Limit, Continuity and differentiability of function of complex variables, Analytic function, Cauchy-Riemann conditions, Cauchy's integral theorem, Cauchy's integral formula, Taylor's and Laurent's series, singular points, residues, Evaluation of residues, Cauchy's residue theorem, Jordan's lemma, evaluation of real definite integrals.		
Unit - 4	**Number of lectures = 10**	**Title of the unit: Integral Transforms**
Fourier series, Dirichlet's conditions, Fourier series of arbitrary period, Half-wave expansions, development of the Fourier Integral, Fourier Integral theorem, Fourier transforms, Properties of Fourier transform.		

12. Brief Description of self-learning / E-learning component

http://nptel.ac.in/courses/115103036/

http://web.mit.edu/al24406/www/mathmeth/DiffForms_SchulzSchulz_10Sep.pdf

https://www.youtube.com/watch?v=LYNOGk3ZjFM

13. Books Recommended

1. G. Arfken and H.J. Weber. Mathematical Methods for Physicists. San Diego: Academic Press. ISBN-10: 0123846544.
2. A.W. Joshi. Matrices and Tensors in Physics. New Delhi: Wiley Eastern. ISBN-10: 8122405630.
3. P.K. Chattopadhyay. Mathematical Physics. New Delhi: Wiley Eastern. ISBN-10: 8122434401.
4. C. Harper. Introduction to Mathematical Physics. New Delhi: Prentice Hall of India. ISBN-10: 8120302621.
5. M.L. Boas. Mathematical Methods in the Physical Sciences. New York: John Wiley. ISBN-10 : 9780471198260
6. L. Pipes and L.R. Horwell. Applied Mathematics for Engineers and Physicists. ISBN-10 : 0486779513.
7. B.S. Rajput. Mathematical Physics. ASIN : B07YCGC4ZS
8. A. K. Ghatak and I. C. Goyal. Mathematical Methods for Physicists. ASIN : B07XDZVYC5

1. Name of the Department: Physics						
2. Course Name	**Mathematical Physics Lab**	**L**	**T**		**P**	
3. Course Code	17080102	0	0		4	
4. Type of Course (use tick mark)		**Core (√)**	**DSE ()**		**SEC ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 0		**Tutorials = 0**	**Practical = 52**			

8. Course Description:

This course will teach you the practical knowledge of how to obtain solutions to systems of linear equations, differential equations, FFT etc. using computational methods.

9. Course Objectives:

This lab introduces students to numerical techniques used for solving mathematical problems that cannot be solved or are difficult to solve analytically.

10. Course Outcomes (COs):

Students will have understanding of:

1. MATLAB/Python basics
2. Various computational methods like matrix manipulation are useful to solve research problems.

11. List of Experiments

1. Pragmatically finding Scalar and Vector Product.
2. Pragmatically finding Eigenvalues and eigenvectors of various matrices.
3. Solving systems of linear equations.
4. Solving second order differential equation.
5. Solution of Legendre equation.
6. Numerically solving Bessel functions of the second kind.
7. Evaluates the Laguerre polynomial, the generalized Laguerre polynomial, and the Laguerre function.
8. Compute and plot a simple sinusoid of amplitude 1 and frequency f=1 for for $0<t<1$.
9. Compute and plot a complex sinusoidal function consisting of the sum of 5 sine waves with equal amplitudes but whose frequencies are 1,3,5,10, and 20, again for t varying from 0 to 2π.
10. Computing Fourier Series and Power Spectrum.
11. Generating various waveforms using arbitrary function generators and using Tektronix Digital Phosphor Oscilloscope and finding its FFT.

Note: The list of the experiment given above should be considered as suggestive of the standard and available equipment. The faculty members are authorised to add or delete from this list whenever considered necessary.

12. Book Recommended:

1. Introduction to Matlab 7 1st Edition 2009 by ETTER, PEARSON INDIA. ISBN 9788131723135.
2. Computational Physics, 2nd edition, Nicholas J. Giordano, Purdue University, Hisao Nakanishi, Purdue University Pearson Education Inc, 2006, ISBN: 978-0131469907.
3. Numerical Methods Kindle Edition by Babu Ram (Author) ASIN: B00G4YDRSS.
4. https://www.mccormick.northwestern.edu/documents/students/undergraduate/introduction-to-matlab.pdf

1. Name of the Department: Physics						
2. Course Name	**Classical Mechanics**	**L**	**T**		**P**	
3. Course Code	17080103	3	0		0	
4. Type of Course (use tick mark)		**Core (√)**	**DSE()**		**SEC()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 40		**Tutorials = 0**	**Practical = 0**			

8. Brief Syllabus:

The syllabus is divided into four units i.e. Lagrangian formulation and Hamilton's principle, rigid body motion, small oscillation and Hamilton equation, and canonical transformation and Hamilton-Jacobi theory.

9. Learning objectives:

The course aims to provide students with an understanding of the basics of Lagrangian formulation, Hamilton's principle and canonical transformation and Hamilton-Jacobi Theory. It also gives the idea how to write Lagrangian and Hamiltonian for the rigid body motion.

10. Course Outcomes (COs):

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

1. Apply the basics involved in the small oscillation and related Hamilton equation and experimental physics as rigid body dynamics with transformation
2. Apply their theoretical, experimental knowledge and conceptualizing their solutions
3. Use classical mechanics's scientific potential to analyze scientific ideas and explanations.
4. Demonstrations and learning of research-based knowledge of different system dynamics, mechanics based practical and project.

11. Unit wise detailed content

Unit-1	**Number of lectures = 12**	**Title of the unit: Lagrangian Formulation & Hamilton's Principle**

Mechanics of a system of particles, constraints of motion, generalized coordinates, D'Alembert's Principle Lagrange's velocity dependent forces (gyroscopic), dissipation function, Application of Lagrangian formulation Hamilton principle, Lagrange's equation from Hamilton principle, extension to non-holonomic systems.

Unit – 2	**Number of lectures = 10**	**Title of the unit: Rigid Body Motion**

Reduction to equivalent one body problem, the equation of motion and first integrals, the equivalent one-dimensional problem, the differential equation for orbits, Kepler's problem (inverse square law), The Euler's angles, rate of change of a vector, Coriolis force.

Unit – 3	**Number of lectures = 10**	**Title of the unit: Small Oscillations & Hamilton Equation**

Euler equation of motion, Torque free motion of rigid body, Eigenvalue equation, Free vibrations, Normal

coordinates, Legendre Transformation, Hamilton's equations of motion, Hamilton's equations from variation principle, Principle of least action.		
Unit – 4	**Number of lectures = 8**	**Title of the unit: Canonical Transformation and Hamilton-Jacobi Theory**
Canonical transformation and its examples, Equation of motion, Poisson's Brackets relations, Conservation Theorems., Hamilton-Jacobi equation Hamilton's principal function, Harmonic Oscillator problem		

12. Brief Description of self-learning / E-learning component:

To understand basic concepts in detail, students may get study materials on following links.

https://onlinecourses.nptel.ac.in/noc18_ph02

http://www.damtp.cam.ac.uk/user/tong/dynamics/clas.pdf

http://courses.physics.ucsd.edu/2010/Fall/physics200a/LECTURES/200_COURSE.pdf

13. Books Recommended

1. Herbert Goldstein, Classical Mechanics Pearson Education; 3 edition (2011) (ISBN: 978-8131758915).
2. J.C. Upadhyaya, Classical Mechanics: Himalaya Publishing House, 2014 (ISBN: 978-9351427988)
3. N.C. Rana and P.S. Joag. Classical Mechanics. Tata McGraw-Hill, 2001, (ISBN: 978-0074603154)
4. Kiran C. Gupta. Classical Mechanics of Particles and Rigid Bodies. New Delhi: Wiley Eastern, 2018 (ISBN: 978-9386649782)

1. Name of the Department: Physics						
2. Course Name	**Classical Mechanics-Lab**	**L**	**T**		**P**	
3. Course Code	17080104	0	0		4	
4. Type of Course (use tick mark)		**Core (√)**	**DSE ()**		**SEC ()**	
5. Pre-requisite (if any)		573472776. **Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()
6. Total Number of Lectures, Tutorials, Practical						
Lectures = 0		**Tutorials = 0**			**Practical = 52**	

7. Course Description:

In this course student will gain the practical knowledge about the Understand laws of motion and their application to various dynamical situations, computer Simulation of projectile motion and orbital mechanics, hyperbolic orbit motion with conic section, Hamilton's Least Action principle for a particle under the action of gravity, Action field of the Kepler/Coulomb problem

8. Course Objectives:

1. Understand laws of motion and their application to various dynamical situations.
2. Understand and study Kepler's laws to describe the motion of planets and satellites in circular orbit.
3. Explain the phenomenon of simple harmonic motion.
4. Study of Hamilton's Least Action principle for a particle under the action of gravity

9. Course Outcomes (COs):

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

1.Visualize the simulation, and correlate the theoretical concepts and identify its practical applications through experiments.
2. Understand laws of motion and their application to various dynamical situations
3. Understand and study of Kepler's laws to describe the motion of planets and satellite in circular orbit
4. Explain the phenomenon of simple harmonic motion
5. Study of Hamilton's Least Action principle for a particle under the action of gravity

10.List of Experiments

1. Simulation of projectile motion and orbital mechanics using both the Classical 4th Order Runge-Kutta method and Euler's Method (Simulation and Computational)
2. Conic section projectile hyperbolic orbit motion (Simulation and Computational)
3. Conic section curves with r min and r max (Simulation and Computational)
4. Hamilton's Least Action principle for a particle under the action of gravity (Computational and Simulation)
5. Attractive Potential, energy, curves for a body under a central force (Computational)
6. Orbit period to obtain the time it takes to go from r min to r max in an orbit due to a force of the form arp (Simulation and Computational)
7. Action field of the Kepler/Coulomb problem (Simulation and Computational)
8. Keplerian orbits and principle (Simulation and Computational)

9. Roll pendulum (Simulation and Computational) (The suspension point $K_1$of a plane pendulum slides frictionless along the x-axis. The pendulum body K_2 has the distance L from the suspension point. Both bodies have the same mass $m_1=m_2=m$ and the connection between K_1 and K_2 is mass less)
10. To determine the height of a building using a Sextant.
11. To determine g and velocity for a freely falling body using Digital Timing Technique.
12. To determine Coefficient of Viscosity of water by the Capillary Flow Method (Poiseuille's method).
13. To determine the Young's Modulus of a Wire by Optical Lever Method.

Note: The list of the experiment given above should be considered as suggestive of the standard and available equipment. The faculty members are authorised to add or delete from this list whenever considered necessary.

11.Book Recommended

References for Laboratory Work:

1.Advanced Practical Physics for students, B. L. Flint and H. T. Worsnop, 1971, Asia Publishing House, ISBN-13 : 978-0423738902

2.Engineering Practical Physics, S. Panigrahi & B. Mallick, 2015, Cengage Learning India Pvt. Ltd. ISBN: 9788131525203

3. Practical Physics, G. L. Squires, 2015, 4/e, Cambridge University Press, ISBN- 9781139164498

4. A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11/e, 2011, Kitab Mahal. ISBN-13 : 978-8122500844.

1. Name of the Department: Physics						
2. Course Name	**Statistical Mechanics**	**L**	**T**		**P**	
3. Course Code	17080105	3	0		0	
4. Type of Course (use tick mark)		**Core (√)**	**DSE ()**		**SEC ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 40		**Tutorials = 0**	**Practical = 0**			

8. Brief Syllabus:

The course is intended to provide an understanding of the phase space and quantum space, canonical systems, in Bose-Einstein condensation, Ising model, random walk, Brownian motion and many more physical phenomenon which cannot be explained using classical mechanics principles.

9. Learning objectives:

The course aims to provide students with an understanding of the basics of phase space, ensembles, and different types of system like canonical, micro-canonical and grand-canonical system. To develop understanding of writing partition functions for these systems.

10. Course Outcomes (COs):

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

1. Understand phase space and canonical system.
2. Write partition functions for the canonical, micro-canonical and grand-canonical systems.
3. Understand the thermodynamic behaviour of an Ideal Bose gas and an Ideal Fermi gas
4. Describe the basic involved in Bose-Einstein condensation, Ising model, random walk and Brownian motion.

11. Unit wise detailed content

Unit-1	**Number of lectures = 8**	**Title of the unit: Basics of statistical mechanics**

Scope and aim of statistical mechanics. Transition from thermodynamics to statistical mechanics. Review of the ideas of phase space, phase points, Ensemble, Density of phase points. Liouville's equation and Liouville's theorem

Unit - 2	**Number of lectures = 12**	**Title of the unit: Canonical systems**

Stationary ensembles: Micro canonical, canonical and grand canonical ensembles. Partition function formulation. Fluctuation in energy and particle. Equilibrium properties of ideal systems: ideal gas, Harmonic oscillators, rigid rotators. Para magnetism, concept of negative temperature.

Unit – 3	**Number of lectures = 12**	**Title of the unit: Quantum mechanical ensembles**

Quantum states and phase space; an ideal gas in quantum mechanical ensembles; Ideal Bose system, basic concepts and thermodynamic behavior of an Ideal Bose gas; Bose-Einstein condensation; Ideal Fermi systems; the thermodynamic behavior of an Ideal Fermi gas, discussion of heat capacity of a free electron gas at low temperatures; Pauli parameters, Boltzmann H-Theorem

Unit – 4	**Number of lectures = 8**	**Title of the unit: Different models**

A dynamical model of phase transitions, Critical indices, Ising model, Thermodynamic fluctuations, random walk, Brownian motion, introduction to non-equilibrium processes, diffusion equation.
11. Brief Description of self-learning / E-learning component:
To understand basic concepts in detail, students may get study materials on following links. https://onlinecourses.nptel.ac.in/noc18_ph02 https://www.cmi.ac.in/~kpnmurthy/StatisticalMechanics2017/book.pdf
12. Books Recommended
1. R.K. Patharia. Statistical Mechanics. 2nd ed. Oxford: Butterworth-Heinemann. ASIN: B0092L8L2W. 2. K. Huang. Statistical Mechanics. New Delhi: Wiley Eastern. ISBN-10: 0471815187. 3. B.K. Agarwal and M. Eisner. Statistical Mechanics. New Delhi: Wiley Eastern. ISBN-10: 8122411576. 4. C. Kittel. Elementary Statistical Physics. New York: John Wiley. ISBN-10: 0486435148. 5. S.K. Sinha. Statistical Mechanics. New Delhi: Tata McGraw Hill. ISBN-10: 8173197172. 6. Suresh Chandra. Textbook of Statistical Mechanics. New Delhi: CBS Publishers. ISBN-10: 8123916086.

1. Name of the Department: Physics						
2. Course Name	**Statistical Mechanics Lab**	**L**	**T**		**P**	
3. Course Code	17080106	0	0		4	
4. Type of Course (use tick mark)		**Core (√)**	**DSE ()**		**SEC ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 0		**Tutorials = 0**	**Practical = 52**			

8. Course Description:

In this course student will gain the practical knowledge about thermocouple & its calibration, Brownian motion, random walk etc

9. Course Objectives:

To determine various parameters like Boltzman constant, coefficient of thermal conductivity, thermo emf, cooling temperature of a hot object etc.

10. Course Outcomes (COs):

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

Correlate the theoretical concepts and identify its practical applications through experiments.

11. List of Experiments

1. To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.
2. Measurement of Planck's constant using black body radiation.
3. To calibrate Resistance Temperature Device (RTD) using Null Method/Off-Balance Bridge.
4. To study the thermocouple and plot the graph between thermo emf vs temperature.
5. Calibration of a thermocouple by potential meter
6. To study the random walk using MATLAB/Python
7. To study the Brownian motion using MATLAB/Python
8. To calculate probability distribution function using MATLAB/Python
9. To determine the coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method.
10. To determine the coefficient of thermal conductivity of copper by Searle's Apparatus.
11. To record and analyze the cooling temperature of a hot object as a function of time using a thermocouple and suitable data acquisition system.

Note: The list of the experiment given above should be considered as suggestive of the standard and available equipment. The faculty members are authorised to add or delete from this list whenever considered necessary.

12. Book Recommended

1. R. A. Dunlup. Experimental Physics: Modern Methods. New Delhi: Oxford University Press, ISBN-0195049497.
2. Introduction to Matlab 7 1st Edition 2009 by ETTER, PEARSON INDIA. ISBN-9788131723135
3. B.K. Agarwal and M. Eisner. Statistical Mechanics. New Delhi: Wiley Eastern. ISBN-10: 8122411576

Ability Enhancement Compulsory Course (AECC)

Semester-I

1. Name of the Department: Physics						
2. Course Name	Professional ethics and human value	**L**		**T**	**P**	
3. Course Code	17080107	2		0	0	
4. Type of Course (use tick mark)		**Core ()**	**DSE ()**	**AECC (✓)**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)	NA	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical		
Lectures = 30	**Tutorials = 0**	**Practical = 0**

8. Course Description:

This course provides students with the knowledge of ethics in professional life. Some of the examples from history and day to day life will make the students more responsible towards their profession, society and family.

9. Course Objectives:

1. To develop ethical and human values in students
2. To develop the responsibility in students at professional and societal levels.

10. Course Outcomes (COs):

1. The students will understand the values of professional ethics and moral values deeply.
2. The students will be able to take strong decisions and perform their duties responsibly as on professional.

11. Unit wise detailed content

Unit-1	**Number of lectures = 8**	**Title of the unit: Ethics and Human Values**

Definition, History and Development of Ethics, Universal declaration on Bioethics. Theories related to Bioethics: Utilitarian theory, Deontological theory and Communication theory

Unit-1	**Number of lectures = 7**	**Title of the unit: Human Values**

Human Rights and Values: Autonomy, Consent, Equality, Confidentiality, Vulnerability and Personal Integrity
Environmental Ethics, Animal ethics

Unit – 2	**Number of lectures = 7**	**Title of the unit: Professional Ethics**

Need and Importance of professional ethics, Goals, Dignity of Labour, IRB & its functions, Authorship

Religious and Cultural Values, Importance of a Family, Guidance to youngsters, Gender Equality

Unit – 2	**Number of lectures = 8**	**Title of the unit: Responsibility**

Responsibilities towards Safety and Risk, Voluntary v/sIn voluntary Risk, Designing/Research for Safety – Risk, Benefit Analysis, Accidents. Disaster ethics,

Ethics in Media and Technology, Research Ethics, Intellectual Property Rights.

12. Brief Description of self learning / E-learning component

https://www.youtube.com/watch?v=cFOZplkRqsk&authuser=2

https://www.youtube.com/watch?v=HJk1Eodmf9A&authuser=2

https://www.youtube.com/watch?v=Fqt7m8LH5GY&authuser=2

https://youtu.be/2VYF_t51FyE

https://youtu.be/hjzA_rZG-bU

13. Books Recommended

1. Professional Ethics and Morals by Prof.A.R.Aryasri, DharanikotaSuyodhana – Maruthi Publications, ISBN (13) : 978-81-224-2301-3
2. Professional Ethics and Human Values by A. Alavudeen, R.Kalil Rahman and M. Jayakumaran – University Science Press, ISBN 0-07-084175-6
3. Professional Ethics and Human Values by Prof.D.R.Kiran-Tata McGraw-Hill – 2013, ISBN : 978-81-224-2301-3

Skill Enhancement Course

Semester-I

1. Name of the Department: Physics						
2. Course Name	**Computational Methods & Programming (Matlab/Python)**	**L**	**T**		**P**	
3. Course Code	17080108	2	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE ()**		**SEC (√)**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 30		**Tutorials** = 0	**Practical** = 0			

8. Course Description:

Many problems in physics need to be solved using computational techniques. This course will teach students how to obtain solutions to system of linear equations, differential equations, etc using computational methods.

9. Course Objectives:

To impart the basic knowledge of computers and MATLAB/Python programming. To give exposure about various computational techniques to solve physics using advanced computer programming languages.

10. Course Outcomes (COs):

1. To have a basic understanding of MATLAB /Python and be able to design, code, and test small programs.
2. Be fluent in the use of procedural statements, assignments, conditional statements, and loops.
3. Self-directed and Life-long Learning.
4. Provide an introduction to the Python programming language.

11. Unit wise detailed content

Unit-1	**Number of lectures = 9**	**Title of the unit: Programming in MATLAB/Python**

Introduction to MATLAB/Python, arrays, loops, Element by element operations, built in function for analysing arrays, Creating and saving script files, output commands. Basic Plotting Functions, Creating a Plot, Plotting Multiple Data Sets in One Graph.

Unit – 2	**Number of lectures = 7**	**Title of the unit: Roots of Equations**

Roots of quadratic equation - Limits for real roots of a polynomial equation – Bisection method, False position method and Newton Raphson method for finding roots of the equations.

Unit – 3	**Number of lectures = 7**	**Title of the unit: Linear Algebra**

Eigenvalues and Eigenvector of matrix-inverse of a matrix- determinant – solution of linear systems of equations- Gauss elimination and pivotal condensation methods.

Unit – 4	**Number of lectures = 7**	**Title of the unit: Integration and differentiation**

Trapezoidal rule-Simpson's rule (one -third) solution of ordinary differential equation by Euler method and Runge-Kutta methods, Monte-Carlo Simulation and its applications

12. Brief Description of self learning / E-learning component

https://www.edx.org/course/programming-basics

https://www.edx.org/course/computational-methods-forpes-harvardx-423x-2

13. Books Recommended

1. Matlab: A Practical Introduction to Programming and Problem Solving 3rd Edition. by Stormy Attaway (Author). ISBN-10 : 0124058760, ISBN-13 : 978-0124058767
2. https://www.math.unipd.it/~mrrusso/Didattica/NA-Yaounde/Manual.pdf.
3. E. Balagurusamy. Numerical Methods. New Delhi: Tata McGraw-Hill, 1999. ISBN-10 : 0074633112, ISBN-13 : 978-0074633113
4. A.K. Ghattak, T.C. Goyal and S.J. Chua. Mathematical Physics. New Delhi: Macmillan, 1995. ISBN-10 : 9386202018, ISBN-13 : 978-9386202017

Semester-II

1. Name of the Department: Physics						
2. Course Name	**Quantum Mechanics**	**L**	**T**		**P**	
3. Course Code	17080201	3	0		0	
4. Type of Course (use tick mark)		**Core (√)**	**DSE ()**		**SEC ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 40		**Tutorials = 0**	**Practical = 0**			
8. Course Description:						
This course will give an introduction to quantum mechanics, beginning with wave mechanics, angular momentum, time evolution, the simple harmonic oscillator, and bra-ket notation. The students will also be made familiar with time independent and independent perturbation theory applied to various problems.						
9. Course Objectives:						
To give exposure about the various tools employed to analyse the quantum mechanical problems.						
10.Course Outcomes (COs):						
After completion of this course, 1. Students will have an understanding of Quantum Physics knowledge. 2. This course will help student in critical thinking and problem Solving 3. Quantum Mechanics course will develop research related skills 4. This course will develop Analytical/Scientific Reasoning in area of Quantum Mechanics						
11.Unit wise detailed content						
Unit-1	**Number of lectures = 10**	**Title of the unit: General formalism of quantum & Schrodinger equations with applications**				
The Schrödinger equations, time dependent and time independent forms, probability current density, expectation values, Ehrenfest's theorem, Gaussian wave packet and its spreading., Exact statement and proof of the uncertainty principle, eigenvalues and Eigenfunctions, wave function in coordinate and momentum representations. Application of Schrodinger equation for a particle in one dimensional Box, tunnelling problem and linear harmonic oscillator.						
Unit – 2	**Number of lectures = 8**	**Title of the unit: Quantum operators**				
Operator in quantum mechanics, Hermitian operator and Unitary operator change of basis, Eigenvalues and eigenvectors of operators, Dirac's Bra and Ket algebra, Linear harmonic oscillator, Coherent states, Time development of states and operators, Heisenberg, Schrodinger and interactive						

pictures.		
Unit – 3	**Number of lectures** = 12	**Title of the unit: Angular momentum**
The angular momentum operators and their representation in spherical polar coordinates, Solution of Schrodinger equation for spherically symmetric (central) potentials, spherical harmonics, Hydrogen atom. Commutators and various commutation relations.		
Unit – 4	**Number of lectures** = 10	**Approximation methods**
Time independent perturbation theory, non-degenerate case, first and second order perturbation, WKB Approximation: WKB method for one-dimensional problems, Application to barrier penetration, WKB method for three dimensional problems, Time-dependent perturbation theory: General expression for the probability of transition from one state to another.		
12.Brief Description of self-learning / E-learning component		
http://nptel.ac.in/courses/115106066/ https://ocw.mit.edu/courses/physics/8-04-quantum-physics-i-spring-2016/lecture-notes/ https://www.ks.uiuc.edu/Services/Class/PHYS480/qm_PDF/QM_Book.pdf		
13.Books Recommended		
1. Schiff. Quantum Mechanics. New Delhi: Tata McGraw-Hill.ISBN: 9780070702431, 9780070702431 2. B. Craseman and J.L. Powell. Quantum Mechanics. New Delhi: Narosa. ISBN-13: 978-0201059205, ISBN-10: 0201059207 3. S. Gasiorowicz. Quantum Mechanics. New York: John Wiley.ISBN: 978-0-471-05700-0 4. J.J. Sakurai. Modern Quantum Mechanics. Addison Wesley.ISBN-10 : 0201539292, ISBN-13 : 978-0201539295 5. P.M. Mathews and K. Venkatesan. Quantum Mechanics. New Delhi: Tata McGraw-Hill.ISBN 10: 0070965102ISBN 13: 9780070965102 6. Ghatak and Lokanathan. Quantum Mechanics. ISBN-10 : 9351382966, ISBN-13 : 978-9351382966 7. M.P. Khanna. Quantum Mechanics. New Delhi: HarAnand.SBN-10 : 812410400X, ISBN-13 : 978-8124104002 8. V.K. Thankappan. Quantum Mechanics. New Delhi: New Age International.ISBN-10 : 9386649217, ISBN-13 : 978-9386649218 9. N. Zettili. Quantum Mechanics: Concepts and Applications.ISBN-10 : 812656105X, ISBN-13 : 978-8126561056		

1. Name of the Department: Physics							
2. Course Name	**Quantum Mechanics-Lab**	**L**	**T**		**P**		
3. Course Code	17080202	0	0		4		
4. Type of Course (use tick mark)		**Core (√)**	**DSE ()**		**SEC ()**		
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()	
7. Total Number of Lectures, Tutorials, Practical							
Lectures = 0		**Tutorials = 0**		**Practical = 52**			

8. Course Description:

In this course student will gain the practical and simulation knowledge about the reflection and transmission of a plane quantum wave at a 1D Woods-Saxon potential, Schrödinger Equation for arbitrary potential, Energy levels with corresponding eigenfunctions, Quantum mechanical scattering problem, of Electron spin resonance- determine magnetic field as a function of the resonance frequency etc.

9. Course Objectives:

1. To study Discrete energy label in Quantum mechanics
2. To study quantum mechanical scattering problem
3. Numerical and exact solution for Schrodinger equation for Particle in a box Quantum harmonic oscillator
4. To study of Zeeman Effect: with external magnetic field; Hyperfine splitting

10. Course Outcomes (COs):

1. Demonstrate the comprehensive and theoretical knowledge of Quantum Mechanics and Schrödinger equations with Angular Momentum operator and representation
2. Various tools to calculate Eigenvalues and total angular momentum of particles
3. Study of Approximation Method and scientific Time independent and dependent perturbation theory
4. To analyze quantum & Schrodinger equations based research and with its applications

11. List of Experiments

1. Eigen Energy Solver for Schrödinger Equation for arbitrary potential (Computational and simulation)
2. GaAs Single Quantum Well (Computational and simulation)
(Calculates the energy levels vs. well widths in a GaAs QW and their corresponding eigenfunctions)
3. Discrete variable representation (DVR) in 1D Quantum Mechanics (Computational and simulation)
4. Gaussian wave packet as solution of the free Schrödinger equation (Computational and siulation)
5. The quantum mechanical binding problem (Computational and simulation)
6. The quantum mechanical scattering problem (Computational and simulation)
(In this practical we will calculate the reflection and transmission of a plane quantum wave at a 1D Woods-Saxon potential using an approach that considers the incoming, the reflected and the transmitted wave parts)
7. Numerical and exact solution for Schrodinger equation for Particle in a box Quantum harmonic oscillator (Computational and simulation)
8. Excited States of Quantum Harmonic Oscillator using Raising Operator (Computational and simulation)

Laboratory Based Experiments:

9. Study of Electron spin resonance- determine magnetic field as a function of the resonance frequency
10. Study of Zeeman Effect: with external magnetic field; Hyperfine splitting

11. Quantum efficiency of CCD

Note: The list of the experiment given above should be considered as suggestive of the standard and available equipment. The faculty members are authorised to add or delete from this list whenever considered necessary.

12. Book Recommended

1. Schaum's outline of Programming with C++. J. Hubbard, 2000, McGraw-Hill Publication
2. An introduction to computational Physics, T. Pang, 2nd Edn.,2006, Cambridge Univ. Press
3. Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific & Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernández.2014 Springer.
4. Scilab (A Free Software to Matlab): H. Ramchandran, A.S. Nair. 2011 S. Chand & amp; Co.
5. A Guide to MATLAB, B.R. Hunt, R.L. Lipsman, J.M. Rosenberg, 2014, 3rd Edn., Cambridge University Press.

1. Name of the Department: Physics						
2. Course Name	**Electrodynamics & Plasma Physics**	**L**	**T**		**P**	
3. Course Code	17080203	3	0		0	
4. Type of Course (use tick mark)		**Core (√)**	**DSE ()**		**SEC ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 40		**Tutorials = 0**	**Practical = 0**			

8. Course Description:

This course aims to provide students with an introduction to the principles and behaviour of dynamical electric and magnetic systems, and a theoretical foundation in classical field theory. Plasma physics is an important subject for a large number of research areas. The primary learning outcome for this course is for the students to learn the basic principles and main equations of plasma physics, at an introductory level, with emphasis on topics of broad applicability.

9. Course Objectives:

To apprise the students regarding the concepts of electrodynamics and its use in various situations. To have a working understanding of the elements of Plasma Physics on topics including: Basic plasma properties; Motion of charged particles in magnetic field; Plasma waves and kinetic representation of plasmas.

10.Course Outcomes (COs):

1. Student will have understanding of evaluate fields and forces in Electrodynamics and Magneto dynamics using basic scientific method

2. This course will help students in critical thinking and problem solving based on electrodynamics using Maxwell's equation and Boundary Conditions.

3. Electrodynamics and plasma physics will have scientific potential to analyze scientific idea and explanation to conclusion method of Images and its applications in branches of Physical Sciences

4. This course will develop Analytical/Scientific Reasoning in the area of Electrodynamics and plasma physics.

11.Unit wise detailed content

Unit-1	**Number of lectures = 12**	**Title of the unit: Electrostatics**

Electric Field, Gauss Law, Differential form of Gauss Law, Electromagnetic scalar and vector potentials, Maxwell's equations in terms of scalar and vector potentials, Non uniqueness of Electromagnetic potentials and concept of Gauge. Lorentz gauge and coulomb gauge. Boundary value problem, Poisson and Laplace equations, Electrostatic potential energy and energy density.

Unit - 2	**Number of lectures = 10**	**Title of the unit: Method of Images**

The method of electrical images. Point charge near an infinite grounded conducting plane, Spherical conductor near point charge: When the sphere is at zero potential or earthed, insulated conducting

sphere near a point charge, when the sphere is kept insulated and carries a total charge e, Conducting sphere in a uniform electric field.		
Unit - 3	**Number of lectures = 10**	**Title of the unit: Electromagnetic Waves and Radiation by Moving Charges**
Wave equation, Reflection and Refraction of electromagnetic waves at a plane interface between dielectrics, Wave propagation in a non-conducting and conducting media, Fresnel relations, Brewster's angle, Wave guides: TE and TM modes in rectangular wave guides; Moving point charges, Retarded potentials, Lienard- Wiechart potentials for a point charge, The fields of moving charge particles, Total power radiated by a point charge: Larmor's formula and its relativistic generalization.		
Unit - 4	**Number of lectures = 8**	**Title of the unit: Plasma Physics**
Elementary concepts, Plasma Oscillation, Electron oscillation in plasma, Electronic oscillations when the motion of ions is also considered. Derivation of plasma oscillation using Maxwell's equation, Propagation of Electromagnetic waves in plasma containing a magnetic field Quasi neutrality of plasma, Debye shielding distance		
12. Brief Description of self learning / E-learning component		
http://nptel.ac.in/syllabus/95102023/ https://nptel.ac.in/courses/115102020/ https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-522-space-propulsion-spring-2015/lecture-notes/MIT16_522S15_Lecture8.pdf		
13. Books Recommended		
1. Classical Electrodynamics by J.D. Jackson. ISBN-13: 978-8126510948 2. Introduction to Electrodynamics by A. Z. Capri and P. V. Panat. ISBN 13: 9788173193293 3. Electrodynamics by S. P. Puri. ISBN NO. 9781842656587 4. Introduction to Electrodynamics by D. J. Griffiths. ISBN-13: 978-0138053260 5. Introduction to Plasma Physics by F. F. Chen. ISBN 978-1-4757-0459-4 6. Introduction to Plasma Theory by D. R Nicholson. ISBN-13: 978-0471090458		

1. Name of the Department: Physics						
2. Course Name	**Electrodynamics & Plasma Physics-Lab**	**L**	**T**	**P**		
3. Course Code	17080204	0	0	4		
4. Type of Course (use tick mark)		**Core (√)**	**DSE ()**	**SEC ()**		
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 0		**Tutorials = 0**	**Practical = 52**			

8. Course Description:

Through this course students will gain practical and simulation knowledge about Lorentz transformation, Boundary value problem with grounded sphere, field strength with variation magnetic field in a solenoid, Brewster's Law and Black body radiation etc.

9. Course Objectives:

1. Study of Lorentz transformation
2. Study with simulation Helmholtz coil Boundary value problem: charge over grounded sphere
3. Study specific e/m measurement
4. Study Brewster's law analysis

10.Course Outcomes (COs):

1. Student will have understanding of evaluate fields and forces in Electrodynamics and Magneto dynamics using basic scientific method
2. This course will help students in critical thinking and problem solving based on electrodynamics using Maxwell's equation and Boundary Conditions.
3. Electrodynamics and plasma physics will have scientific potential to analyze scientific idea and explanation to conclusion method of Images and its applications in branches of Physical Sciences
4. This course will develop Analytical/Scientific Reasoning in the area of Electrodynamics and plasma physics.

11. List of Experiments

1. Lorentz transformation LT (Simulation and Computational)
2. Helmholtz coil (Simulation and Computational)
3. Boundary value problem: charge over grounded sphere (Simulation and Computational)
4. e/m Ratio measurements
5. Measurement of field strength B and its variation in a solenoid (determine dB/dx)
6. To determine self-inductance of a coil by Rayleigh's method and Anderson's bridge.
7. To determine the mutual inductance of two coils by Absolute method.
8. Black body Radiation
9. Measurement of charge sensitivity, current sensitivity and CDR of Ballistic Galvanometer
10. To verify Brewster's Law and to find Brewster's angle.
11. To study the polarization of light by reflection and determine the polarizing angle for air-glass interface.
12. To study the reflection, refraction of microwaves
13. Production and characterization of plasma

Note: The list of the experiment given above should be considered as suggestive of the standard and

available equipment. The faculty members are authorised to add or delete from this list whenever considered necessary.

12.Book Recommended:

1. Advanced Practical Physics for students, B.L.Flint & H.T.Worsnop, 1971, Asia Publishing House.
2. Engineering Practical Physics, S. Panigrahi and B.Mallick, 2015, Cengage Learning India Pvt. Ltd.
3. A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed.2011, Kitab Mahal.
4. Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University Press

1. Name of the Department: Physics						
2. Course Name	**Atomic and Molecular Physics**	**L**	**T**		**P**	
3. Course Code	17080205	3	0		0	
4. Type of Course (use tick mark)		**Core (√)**	**DSE ()**		**SEC ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 40		**Tutorials = 0**	**Practical = 0**			

8. Course Description:

Atom and molecule are the fundamental unit for all matters in universe. Matter, whatever the states, is made of atoms. The properties of all matters are governed by the electronic structure of atom and molecule. They have individual properties like electronic, magnetic and optical properties, which are quite different from the collective properties of matter made of atoms and molecules. This course will enlighten the knowledge of atoms and molecules and build up the pre-requisite knowledge for all science and engineering field.

9. Course Objectives:

1. Comparing between atomic emission spectroscopy and atomic absorption spectroscopy; Optical spectroscopy, Atomic spectrum Molecular spectroscopy
2. Theory of magnetic energy, Anomalous Zeeman's effect and Landue splitting factor.
3. Molecular Spectra of diatomic molecules Vibrational and Rotational energy levels.
4. To learn basics of NMR & ESR.

10.Course Outcomes (COs):

After going through this course, the students

1. Will acquire the knowledge of atoms and molecules and their significance in scientific studies
2. Understand the spectroscopy techniques to study various type of spectra
3. Learn and acquire skills to demonstrate and apply these techniques research and development
4. Will be able to utilize knowledge for innovation and scientific understanding for the benefit of society

11.Unit wise detailed content

Unit-1	**Number of lectures = 11**	**Title of the unit: Atomic Physics**

Space Quantisation and Stern-Gerlach Experiment, L-S And J-J Coupling: Terms of Equivalent and Non-Equivalent Electron Atom, Breit's Scheme, Normal and Anomalous Zeeman Effect, Paschen-Back Effect And Stark Effect, Hyperfine Structure Of Spectral Lines: Isotope Effects, Nuclear spin and Hyperfine Splitting, Intensity Ratio and Determination Of Nuclear Spin.

Unit - 2	**Number of lectures = 10**	**Title of the unit: Microwave and Infra-Red Spectra**

Types Of Molecules, Diatomic Molecule as Rigid Rotator, its Energy Level, Spectra and Intensities Of Spectral Lines, Effect of Isotopic Substitution, Diatomic Molecule as Non-Rigid Rotator. Vibrating Diatomic Molecule: Energy of A Diatomic Molecule, Simple Harmonic Oscillator, An-harmonic Oscillator, Diatomic Vibrating Rotator.

Unit - 3	**Number of lectures = 10**	**Title of the unit: Electronic Spectra of Diatomic Molecules**

The Born-Oppenheimer Approximation, Vibrational Coarse Structure: Progressions, Intensity of Vibrational-Electronic Spectra: The Franck-Condon Principle, Dissociation Energy and Dissociation Products, Rotational Fine Structure Of Electronic-Vibrational Transitions, The Fortrat Parabola, Pre-dissociation. Electronic Structure Of Diatomic Molecules.

Unit - 4	**Number of lectures = 09**	**Title of the unit: Raman Spectroscopy**

Raman Spectroscopy, Experimental Arrangement For Raman Spectra, Classical Theory Of Raman Effect, Quantum Theory of Raman Effect, Rotational Raman Spectra, Vibrational Raman Spectra and Molecular Structure.

12. Brief Description of self learning / E-learning component

For understanding the basic concepts in detail, students may get the study materials from these E-learning links

https://ocw.mit.edu/courses/physics/

https://nptel.ac.in/courses/104104085/

https://nptel.ac.in/courses/115105100/56

13. Books Recommended

1. Collin N Banwell and Elaine M McCash, Fundamentals of Molecular Spectroscopy 4th edition: Tata McGraw- Hill (ISBN: 978-9352601738).
2. Raj Kumar, Atomic, Molecular Spectra: Laser, KedarNath Ram Nath (ISBN: 978-9380803302).
3. H Kaur, Spectroscopy: Pragati Prakashan (ISBN: 978-9386306425).
4. Atomic spectra & atomic structure, Gerhard Hertzberg: Dover publication, New York (ISBN: 978-0486601151)

1. Name of the Department: Physics							
2. Course Name	**Atomic and Molecular Physics-Lab**	**L**		**T**		**P**	
3. Course Code	17080206	0		0		4	
4. Type of Course (use tick mark)		**Core (√)**		**DSE ()**		**SEC ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**		Even (√)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical							
Lectures = 0		**Tutorials = 0**		**Hours = 52**			

8. Course Description:

Atom and molecule are the fundamental unit for all matters in universe. Matter, whatever the states, is made of atoms. The properties of all matters are governed by the electronic structure of atom and molecule. They have individual properties like electronic, magnetic and optical properties, which are quite different from the collective properties of matter made of atoms and molecules. This course will enlighten the practical knowledge of atoms and molecules by learning through experiments and build up the pre-requisite knowledge for all science and engineering field.

9. Course Objectives:

1. Comparing between atomic emission spectroscopy and atomic absorption spectroscopy; Optical spectroscopy, Atomic spectrum
2. Molecular spectroscopy
3. Molecular Spectra of diatomic molecules Vibrational and Rotational energy levels.

10.Course Outcomes (COs):

Acquire practical knowledge of

1. Measurement and analysis of different types of spectra
2. Applications of Raman spectroscopy in study of molecules
3. State and explain the key properties of many electron atoms.
4. Explain the observed dependence of atomic spectral lines on externally applied electric and magnetic fields.
5. State and justify the selection rules for various optical spectroscopies in terms of the symmetries of molecular vibrations.

11. List of Experiments (Perform at least eight experiments)

1. Study of Fine structure of Hg Spectral lines using constant deviation spectrometer
2. Study of Hyperfine structure using Febry Perot's Interferometer
3. Raman scattering using a Laser source
4. Measurement and analysis of atomic spectra
5. Measurement and analysis of electronic spectra of Molecules
6. Measurement and analysis of electronic spectra of liquids
7. Measurement and analysis of vibrational spectra of Molecules
8. Measurement and analysis of rotational spectra of Molecules
9. Measurement and analysis of Raman spectra of liquids
10. Measurement and analysis of Raman spectra of Molecules
11. Measurement and analysis of absorption spectra of solids
12. Determination of Hall coefficient
13. Analysis of Rotational spectrum of N_2 (Raman Spectrum)
14. Analysis of Rotational –vibrational spectrum of di-atomic molecule.

15. Analysis of Band spectrum of molecules.

Note: The list of the experiment given above should be considered as suggestive of the standard and available equipment. The faculty members are authorised to add or delete from this list whenever considered necessary.

For understanding the basic concepts in detail, students may get the study materials from these E-learning links

https://ocw.mit.edu/courses/physics/

https://nptel.ac.in/courses/104104085/

https://nptel.ac.in/courses/115105100/56

12. Books Recommended

1. Advanced Practical Physics for students, B.L. Flint & H.T. Worsnop (1979), Asia Publishing House (ISBN-13 : 978-0423738902)
2. Advanced level Physics Practical's, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted (I 985), Heinemann Educational Publishers
3. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, I I th Edition, (2011), Kitab Mahal, New Delhi.(ISBN-13 : 978-8122500844; ISBN-10 : 8122500846)
4. Physics Lab Manual, Misra and Misra, (2000), South Asian Publishers (ISBN 10: 8170032962 / ISBN 13: 9788170032960)
5. Experiments in Modern Physics, H. Mark, N.Thomas Olson (1966), McGraw Hill (ISBN 10: 007040383X ISBN 13: 9780070403833)
6. Advanced Practical Physics Vol. II, S.P.Singh (2017), Pragati Prakashan (ISBN:: 978-93-86306-93-7;)

Semester-II

1. Course Name	Research Methodology and Technical Writing		**L**	**T**	**P**	
2. Course Code	17080207		2	0	0	
3. Type of Course (use tick mark)		**Core ()**	**DSE ()**		**AECC (✓)**	
4. Pre-requisite (if any)	B.Sc.	**5. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()

6. Total Number of Lectures, Tutorials, Practical

Lectures = 30	**Tutorials = Nil**	**Practical = Nil**

7. Course Description:

This course offers an overview of research methodology including basic concepts employed in quantitative and qualitative research methods. The need for research and literature review, steps in conducting research, research methods associated with conducting scholarly research, lab safety measures, ethical, legal social & scientific issues in research are included.

8. Course Objectives:

The objectives of this course are to:

1. understand some basic concepts of research and its methodologies
2. identify appropriate research topics
3. select and define appropriate research problem and parameters
4. organize and conduct research in a more appropriate manner
5. write a research report and thesis

9. Course Outcomes (COs):

On completion of the course, each student will be able to:

1. have basic knowledge on qualitative research techniques.
2. have adequate knowledge on measurement & scaling techniques as well as the quantitative data analysis.
3. demonstrate knowledge of research processes (reading, evaluating, and developing).
4. perform literature reviews using print and online databases.
5. identify, explain, compare, and prepare the key elements of a research proposal/report.

10. Unit wise detailed content

Unit-1	**Number of lectures = 8**	**Title of the unit: Introduction of Research Methodology**

Introduction and basic concepts in Research Methodology: Meaning of research, objectives and significance of research, Criteria for good research & problems encountered by research scholars.

Unit-2	**Number of lectures = 8**	**Title of the unit: Identification of Research Problems**

Research Problem: Necessity and techniques of defining research problem, Formulation of research problem, Objectives of research problem

Literature search- source of information

Unit – 2	**Number of lectures = 8**	**Title of the unit: Research Design**

Research Design: Meaning, need and features of good research design, Basic Principles of Experimental

Designs, Design of experiments and performing experiment.

Data Collection and Validation: Primary & secondary data collection, case study method etc. Data preparations, processing, analysis & interpretation

Unit – 4	**Number of lectures = 6**	**Title of the unit: Report Writing**

Writing of report: Basic concepts of paper, their writing, review of literature, Concepts of Bibliography and References, significance of report writing, steps of report writing

11. Brief Description of self learning / E-learning component

1. http://www2.ift.ulaval.ca/~chaib/IFT-6001/articles/RMethodology_Marzuki_1.pdf
2. https://shodhganga.inflibnet.ac.in/bitstream/10603/71970/14/14_chapter%204.pdf
3. http://www.tamuc.edu/academics/cvSyllabi/syllabi/201440/40503.pdf

12. Books Recommended

1. Blum, Deborah and Mary Knudson, eds. A field guide for science writers: the official guide of the National Association of Science Writers, New York: Oxford University Press, 1997.
2. Davis, Martha. Scientific Papers and Presentations. San Diego: Academic Press, 1997.
3. Fuscaldo, AA, Erlick, BI, Hindman, B. Laboratory Safety: Theory and Practice. New York: Academic Press, 1980.
4. Bajpai, PK. Biological Instrumentation and Methodology. New Delhi: S. Chand & Co. Ltd. 2006.
5. CR Kothari, Research Methodology: Methods & techniques, Gaurav Garg. New Age Publishers.

Semester-II

1. Name of the Department: Physics						
2. Course Name	Physics of Nanomaterials	**L**	**T**		**P**	
3. Course Code	17080208	2	0		0	
4. Type of Course (use tick mark)		Core ()	DSE ()		SEC (√)	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem()	EverySem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 30		**Tutorials = 0**	**Practical = 0**			

8. Course Description:

It includes Fundamental of Nanomaterials, Nanofabrication Techniques, Characterization of Nanomaterials and Nanomaterials and Devices

9. Course Objectives:

The course aims to provide students with an understanding of the basics of nanomaterials, techniques used in fabrication of nanomaterials, characterization of different types of nanomaterials. It also gives the idea how to design electric devices, magnetic and gas sensors etc. using nanomaterials.

10. Course Outcomes (COs):

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

1. understand the fundamentals of nanomaterials.

2. understand different fabrication techniques for the nanomaterials

3. understand the basics of the different characterization techniques used in basic research in the field of nanoscience.

3. describe the basic involved in the design of devices based on nanotechnology.

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit:** Fundamental of Nanomaterials

Definition of nanotechnology, Nanomaterials, Novel combination of properties of materials of nanoscale, Functional enhancement, Size dependence on melting point, Size dependence on vapour pressure, Nucleation, Size dependence on Chemical reactivity, Intermolecular interactions, Size dependence on Surface tension of solid surfaces, Quantum confinement & energy levels, Band structure, Density of states in 0D, 1D, 2D & 3D materials, Quantum dots, wires, & wells.

Unit – 2	**Number of lectures = 7**	**Title of the unit:** Nanofabrication Techniques

Top down and bottom up approaches to nanofabrication, Nucleation & growth mechanism, Optical & electron beam lithography, Thin films deposition, Evaporation, Sputtering, Electrode position and sol Gel Technique, Plasma assisted chemical vapour deposition, Molecular beam epitaxy, Atomic layer deposition.

Unit – 3	**Number of lectures = 7**	**Title of the unit:** Characterization of Nanomaterials

X-ray diffraction techniques, Scanning transmission electron microscopy, SEM, TEM, Contact &Non-contact methods of surface characterization, Atomic force microscopy, Surface plasma resonance techniques, Electron spectroscopy techniques like AES, XPS, SIMS

Unit – 4	**Number of lectures = 6**	**Title of the unit:** Nanomaterials and Devices

Carbon based nanomaterials, Small and Large Fullerenes and Other Buckyballs, Carbon nanotubes and their Electronic structure, Graphene, Metal matrix composites, Single electron devices, Molecular electronic devices, Coupled quantum dots, Spintronics, Ultra-sensitive magnetic sensors, Spin dependent transistors,

Photonic devices,

12. Brief Description of self-learning / E-learning component:

To understand basic concepts in detail, students may get study materials on following links.
https://onlinecourses.nptel.ac.in/noc18_ph02
https://ocw.mit.edu/courses/physics/
https://www.mooc-list.com/

13. Books Recommended

1. John H. Davies. The Physics of Low Dimensional Semiconductors. Cambridge University Press.
2. J.J. Ramsden. Nanotechnology- An Introduction. William Andrew Elsevier.
3. Ning Xi and King W. Chiu Lai. Nano-optoelectronics Sensors and Devices. William Andrew Elsevier.
4. V.V. Mitin, V.A. Kochetp and M.A. Stroscio. Quantum Heterostructures: Microelectronics and Optoelectronics. Cambridge University Press.
5. G. Cao. Nanostructures and Nanomaterials: Synthesis, Properties and Applications. Imperial College Press.
6. C.P. Poole and F.J. Owens. Introduction to Nanotechnology. New York: John Wiley. M. Wilson, K. Kannangara, M. Simmons and B. Raguse. Nanotechnology. Overseas Press.

Semester-III

1. Name of the Department: Physics						
2. Course Name	**Lasers and its applications**	**L**	**T**		**P**	
3. Course Code	17080301	2	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE ()**		**SEC (√)**	
5. Pre-requisite (if any)	Physics at graduation level	**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical		
Lectures = 30	**Tutorials = 0**	**Practical = 0**

8. Course Description:

This course provides an introduction to the fundamental principles governing the operation and design of coherent light sources and applications of lasers.

9. Course Objectives:

The aim of this course is to

1. understand the fundamentals of LASERs.
2. understand the unique properties of LASERs.
3. explain the different types of LASERs.
4. demonstrate the applications of LASER.

10. Course Outcomes (COs):

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

1. describe spontaneous and stimulated emission, population inversion and other basic concepts of LASER.
2. describe properties of LASER and various methods of pulsing techniques.
3. understand the construction and working of different types of LASER.
4. understand the applications of different LASERs

10. Unit wise detailed content

Unit-1	**Number of lectures = 8**	**Title of the unit: Basic concepts of LASER**

Introduction to LASERs, Interaction of Light with matter, Einstein's concept of stimulated emission, Calculation of Einstein's coefficients, Population inversion, 3-level system and 4-level system, components of LASERs,

Unit – 2	**Number of lectures = 7**	**Title of the unit: Properties of Laser & Pulsing techniques**

Modes of LASER cavity and standing waves, Transverse modes of Laser Cavity. Continuous and pulsed Lasers. Properties of Laser: Directionality, Intensity, Coherence and Monochromaticity.
Pulsing Techniques: Cavity dumping, Q – switching, Mode locking.

Unit – 3 **Number of lectures = 8** **Title of the unit: Types of LASERs**

Types of Lasers: Solid State LASERs (Ruby LASER), Atomic and Ionic Gas LASERs (He-Ne LASER), Molecular Gas LASERs (CO_2 $LASER$$CO_2$ $LASER$), Chemical LASERs (Iodine LASER).

Unit – 4 **Number of lectures = 7** **Title of the unit: LASER applications**

Laser applications: Medical, Defense and Transport usages, LIDAR technique, Internet of Thing sensors,

rocket navigation, communication, LASER spectroscopy, barcode processing, printing.
11. Brief Description of self -learning / E-learning component
https://nptel.ac.in/courses/104104085/12 https://ocw.mit.edu/resources/res-6-005-understanding-lasers-and-fiberoptics-spring-2008/laser-fundamentals-i/
12. Books Recommended
1. A.K. Katiyar, C.K. Pandey, Manisha Bajpai, Fundamentals of Laser Systems and Applications, Wiley, ISBN : 978-8126568260 2. Dr M N Avadhanulu, Dr P S Hemne, An Introduction to Lasers: Theory and Applications, S Chand, ISBN: 9788121920711 3. K Thyagrajan, AGhatak, Lasers: Fundamentals and Applications, Springer, ISBN : 978-9352745531

Discipline Specific Elective Course (DSEC)

Semester-III

Electronics

1. Name of the Department: Physics						
2. Course Name	**Semiconductor Devices**	**L**	**T**		**P**	
3. Course Code	17080303	3	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE (√)**		**SEC ()**	
5. Pre-requisite (if any)	Physics at graduation level	**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 40		**Tutorials = 0**	**Practical = 0**			

8. Course Description:

The course is intended to provide an understanding of the semiconductor devices used in the current semiconductor industry. It caters to undergraduate and graduate students with a diverse background in Materials Science, and Physics. The course provides the students with the basic physics behind semiconductor materials, types of semiconductors, and the reason for the dominance of silicon in the electronics industry. The course also covers the basics of devices with emphasis on their electronic characteristics. Optical devices like LEDs, lasers, solar cells, and their properties will also be explained.

9. Course Objectives:

1. To study the basics of electronic components
2. To study the basic concept and characteristics of electronic devices and circuits.
3. To observe the characteristics of optical devices like LED, lasers and Solar cells
4. To get familiar with the different types of operational amplifiers

10. Course Outcomes (COs):

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

1. Apply the concept of semiconductor physics
2. Apply the concepts of basic electronic devices to design various electronic circuits
3. Understand operation of diodes, transistors (JFET, MOSFET) in order to design basic and advanced circuits
4. Understand the working principle and uses of Solar Cell, PIN diodes and LEDs in practical life
5. Design of electronic circuits using Op-Amp for various practical applications

11. Unit wise detailed content

Unit-1	**Number of lectures = 12**	**Title of the unit: Basic Semiconductor Devices**

P-N junction diode, Capacitance of p-n junctions, switching diodes, Clippers & Clampers, Photoconductors, photodiode, light emitting diodes and liquid crystal display, Junction Field Effect Transistor (JFET) : Basic structure & Operation, pinch off voltage, Single ended geometry of JFET, Volt Ampere characteristic, Transfer Characteristics, JFET as Switch and Amplifier. MOSFET: Enhancement MOSFET, Threshold Voltage, Depletion MOSFET, comparison of p & n Channel FET, SCR, 4-layer pnpn devices, Tunnel diode

Unit – 2	**Number of lectures = 8**	**Title of the unit: Optoelectronic Devices**

Radiative and non-radiative transitions, Solar Cell: basic characteristics, radiation effects and fill factor, Light

dependent resistance (LDR), photodiodes, PIN diodes, metal semiconductor, avalanche photodiode, Light emitting diodes (LEDs), semiconductor diode lasers, Photo transistor.		
Unit – 3	**Number of lectures = 10**	**Title of the unit: MOS systems and SPICE**
Metal semiconductor contacts, Ideal MS contacts, Schottky barriers and ohmic contacts, Oxide and interface charges, Origin of oxide charges, MOS structure, Effect of bias voltage Capacitance of MOS system, Introduction to electrical computer simulation, SPICE and its evaluations, Electrical circuit specifications, The SPICE DC analysis.		
Unit – 4	**Number of lectures = 10**	**Title of the unit: Operational Amplifier**
Differential Amplifier: Circuit configuration, dual input balanced output different amplifier, Inverting and Non-inverting inputs, CMRR, Operational Amplifiers: Block diagram, open and close loop configuration, inverting & non-inverting amplifier, Op-amp with negative feedback Voltage series feedback, Effect of feedback on closed loop voltage gain, Input resistance, output resistance, band width, output offset voltage, Measurements of Op-amp parameters. Op-amp Application: D.C. and A.C. amplifier, summing, scaling and Averaging amplifier, Integrator, Differentiator, Electronic analog computation comparator.		
12. Brief Description of self-learning / E-learning component		
For understanding the basic concepts in detail, students may get the study materials from these E-learning links https://ocw.mit.edu/courses/physics/ **https://nptel.ac.in/courses/117107094/** **https://www.youtube.com/watch?v=CeD2L6KbtVM**		
13. Books Recommended		
1. J. Millman and C. C. Halkies, Integrated Electronics. Tata McGraw-Hill, ISBN: 978-0-07-462245-2. 2. R. P. Jain. Modern Digital Electronics, Tata McGraw Hills, ISBN: 9780070669116 3. Malvino and Leach, Digital Electronics, ISBN- 978-0-07-014170-4 4. S. M. Sze, Semiconductor Devices: Physics and Technology, ISBN-13: 978-8126516810 5. Ramakanth A. Gayakwad, Op-Amps & Linear Integrated Circuits. 2nd ed, ISBN-13: 978-8120320581 6. A.P. Malvino and Donald, Principal and Application in Electronics. Tata McGraw-Hill, ISBN : 0070141703 7. J. D. Rayder, Fundamental of electronics, ISBN-13: 978-8120300828		

1. Name of the Department: Physics						
2. Course Name	**Semiconductor Devices Lab**	**L**	**T**		**P**	
3. Course Code	17080304	0	0		4	
4. Type of Course (use tick mark)		**Core ()**	**DSE (√)**		**SEC ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 0		**Tutorials = 0**	**Practical = 52**			

8. Course Description:

In this course students will gain practical knowledge about various semiconductor and optoelectronic devices like JFET, MOSFET, LED etc. and use of op amp for different arithmetic operations.

9. Course Objectives:

To study the characteristics of JFET, MOSFET, SCR, Solar cell

To use Op-amp for different arithmetic operations, square, ramp generator and Wein bridge oscillator

10. Course Outcomes (COs):

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

Correlate the theoretical concepts and identify its practical applications through experiment procedure and results.

11. List of Experiments

1. To study the characteristics of Junction Field Effect Transistor.
2. To study the characteristics of Metal Oxide Semiconductor Field Effect Transistor
3. To study the characteristics of SCR and its application as a switching device.
4. To use Op-Amp for different Arithmetic Operations.
5. To use Op-Amp as Square, Ramp Generator and Wien Bridge Oscillator
6. To study the characteristics of a solar cell and calculate its fill factor.
7. To design an (i) inverting amplifier and (ii) non-inverting amplifier, of a given gain using operational amplifier.
8. To use Op-Amp as Full Wave Rectifier.
9. To study the characteristics of optoelectronics Devices (LED, photo-detector).
10. To design combinational Logic Circuits.

Note: The list of the experiment given above should be considered as suggestive of the standard and available equipment. The faculty members are authorised to add or delete from this list whenever considered necessary.

12. Book Recommended:

1. R. A. Dunlup. Experimental Physics: Modern Methods. New Delhi: Oxford University Press, ISBN-0195049497
2. B. K. Jones. Electronics for Experimentation and Research. Prentice-Hall, ISBN 13: 9780132507547

1. Name of the Department: Physics						
2. Course Name	**Digital Electronics**	**L**	**T**		**P**	
3. Course Code	17080305	3	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE (√)**		**SEC ()**	
5. Pre-requisite (if any)	Physics at graduation level	**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 40		**Tutorials = 0**	**Practical = 0**			

8. Course Description:

This course will deepen your understanding of the Number system, Boolean Algebra, logic gates, Flip Flops and A/D and D/A convertors

9. Course Objectives:

1. To study the working principle logic gates.
2. To study the basic of flip-flops, memory devices and its related electronic circuits.
3. To understand the different types of logic circuits and its various application.
4. To study the basics of A/D and D/A convertors.
5. To study the basic of shift registers and counters

10. Course Outcomes (COs):

After successful completion of the course, students will

1. have a basic knowledge of various number system and Boolean Algebra.
2. understand the concept of working of different types of logic gates.
3. be able to design the electronic circuits like Flip Flop, RAM, ROM using different types of logic gates.
4. Understand the basic of shift registers & counters and their uses in design of advance electronic equipments
5. know basic D/A & A/D Converters and their applications in communication system.

11. Unit wise detailed content

Unit-1	**Number of lectures = 12**	**Title of the unit: Various Number system, Boolean Algebra and Combinational Logic**

Various Number system and their arithmetic: binary number system, 2's compliment, Octal number system, hexadecimal number system, BCD codes, Gray codes, Review of Boolean Laws & Theorems; Logic Families; TTL NAND operation, Gate circuits; Standard forms of Boolean expressions (SOP & POS form) and their implantation; Karnaugh simplification of SOP & POS expressions, Don't care conditions. Multiplexer and Demultiplexer; Comparators, Encoder and Decoder; Parity generators and checkers, Adder-Subtract circuits

Unit – 2	**Number of lectures = 10**	**Title of the unit: Flip Flops and Memory Devices**

Flip-Flops: Clock waveform and its characteristics; RS, JK, JK master slave, Timer-555, D and T Flip Flops. Memories: ROM, PROM and EPROM, RAM, Static and Dynamic Random Access Memories (SRAM and DRAM), content addressable memory, other advanced memories.

Unit – 3	**Number of lectures = 8**	**Title of the unit: Shift Registers and Counters**

Types of Registers: Buffer register, control register, Shift Registers (SISO, SIPO, PISO and PIPO), Control shift register; Counters: Modulus of Counter; ripple counters, ring counter, Asynchronous 2-bit, Up/Down and decade counter; Design of synchronous counter (Mod-8), TTL counter.

Unit – 4	**Number of lectures = 10**	**Title of the unit: D/A and A/D Converters**

D/A Convertors: Weighted Register Network and R-2R Network, A/D Converters: Parallel comparator A/D converter, successive approximation A/D converter, Counting A/D converter, Dual slope A/D converter, A/D

converter using voltage to frequency and voltage to time conversion – accuracy and resolution. D/A converter resistive network, accuracy and resolution.

12. Brief Description of self learning / E-learning component

For understanding the basic concepts in detail, students may get the study materials from these E-learning links
https://ocw.mit.edu/courses/physics/

https://nptel.ac.in/courses/117107094/

https://www.youtube.com/watch?v=CeD2L6KbtVM

13. Books Recommended

1. Integrated electronics – Millman & Halkias, Tata McGraw-hill, ISBN-13: 978-0070151420
2. Microprocessor and Interfacing – D. V Hall, ISBN-13: 978-0070601673
3. Micropressor Architecture Prog. & Appls. , S. Goankar, Wiley-Estern, ISBN-13: 978-8187972099
4. Digital Computer Electronics – AP. Malvino, ISBN-13: 978- 0028005942
5. Advanced Electronic Communication system by Kennedy, ISBN-13: 978-9352606603
6. Modern digital electronics by R. P. Jain, ISBN-10: 0070681074

1. Name of the Department: Physics						
2. Course Name	**Digital Electronics Lab**	**L**	**T**		**P**	
3. Course Code	17080306	0	0		4	
4. Type of Course (use tick mark)		**Core ()**	**DSE (√)**		**SEC ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 0		**Tutorials = 0**	**Practical = 52**			

8. Course Description:

Through this course students will gain practical knowledge about circuit design and working of flip flops, UJT, coder –decoder, DAC, ADC etc.

9. Course Objectives:

To study JK, SR flip flop, multiplexer, demultiplexer, decoder, phase shifter and UJT.

To study the working of DAC and ADC.

To determine the CMRR, Input offset voltage and input off set current of an Op-amp.

To determine hall coefficient

10. Course Outcomes (COs):

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

Correlate the theoretical concepts of digital electronics and identify its practical applications through experiment procedure and results.

11. List of Experiments

1. To study SR and JK flip flop circuits using logic gates.
2. To study the UJT Characteristics.
3. To study the use of Digital Comparator.
4. To study use of multiplexer, de-multiplexer, decoder and phase shifter.
5. To measure input offset voltage, input bias current, input offset current and CMRR of Op-Amp.
6. To study the working of DAC and measure resolution and setting time of DAC.
7. To study working of ADC and measure resolution and conversion time of ADC.
8. Two probe method for resistivity measurement.
9. To study Hall effect in semiconductor to determine Hall voltage, concentration of charge carriers and the type of semiconductor etc.
10. To measure the band gap of Germanium using four probe method.

Note: The list of the experiment given above should be considered as suggestive of the standard and available equipment. The faculty members are authorised to add or delete from this list whenever considered necessary.

12. Book Recommended:

1. R. A. Dunlup. Experimental Physics: Modern Methods. New Delhi: Oxford University Press, ISBN-0195049497
2. B. K. Jones. Electronics for Experimentation and Research. Prentice-Hall, ISBN 13: 9780132507547

1. Name of the Department: Physics						
2. Course Name	**Analog and Digital Communication**	**L**	**T**		**P**	
3. Course Code	17080307	3	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE (√)**		**SEC ()**	
5. Pre-requisite (if any)	Physics at graduation level	**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical

Lectures = 40	**Tutorials = 0**	**Practical = 0**

8. Course Description:

This course will deepen your understanding of the different processes to grow the single crystal silicon which will help you to fabricate the different types of integrated circuits (ICs) for the particular applications. It also helps you to understand the techniques for making contact between semiconductor and metals.

9. Course Objectives:

1. To study the basics of analog communication system
2. To study the basics of digital modulation system.
3. To understand the sampling and quantization.
4. To get familiar with ASK, FSK, and PSK.

10. Course Outcomes (COs):

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

1. have a basic knowledge of analog and digital communication system
2. understand the techniques behind the sampling and quantization in digital communication
3. know the working principle of ASK, FSK, & PSK and their practical applications
4. have a basic knowledge of information theory and its uses in communication

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Analog Communication**

Basics of Communication system, Need of Modulation, Types of analog modulation, Amplitude Modulation, De-modulation of AM waves, Frequency Modulation, Phase Modulation, Transmitter (Block Diagram) and its characteristics feature, Super heterodyne receiver and its characteristics, Radar & Radar range equation.

Unit – 2	**Number of lectures = 10**	**Title of the unit: Digital Modulation System**

Digital Modulation System: Sampling Theorem, Signal reconstruction in Time Domain, Practical and flat-top sampling, sampling of band pass signal; types of analog pulse modulation, method of generation and detection of PAM, PWM and PPM, spectra of pulse modulated system; Discretization in time and amplitude, Signal to quantization noise ratio, non-uniform quantizer; Encoding and Pulse Code Modulation, Bandwidth of PCM, DPCM, DM, Idling noise and slope overload.

Unit – 3	**Number of lectures = 10**	**Title of the unit: Digital Modulation Techniques**

Digital Modulation Technique: Fundamental of TDM, Electronic Commutator, Types of Digital Modulation, Waveform for ASK, FSK, and PSK, Differential Phase Shift Keying, QPSK and MSK

Unit – 4	**Number of lectures = 10**	**Title of the unit: Information Theory**

Information Theory: Concept of Information Measure, Entropy and Information rate, conditional entropy and redundancy, Source coding, Fixed and variable length codes, Source coding theorem, Shannon–Fano and

Huffman coding for 1st , 2nd and 3rd order extension, Mutual information and channel capacity of discrete memory less channel, Hartley – Shannon Law

12. Brief Description of self-learning / E-learning component

For understanding the basic concepts in detail, students may get the study materials from these E-learning links

https://ocw.mit.edu/courses/physics/

https://nptel.ac.in/courses/108108111/3

https://nptel.ac.in/courses/117103066/7

13. Books Recommended

1. J. Millman and C. C. Halkies, Integrated Electronics. Tata McGraw-Hill, ISBN: 9781405127875
2. S. M. Sze, Semiconductor Devices: Physics and Technology, ISBN- 13: 978-0470537947
3. Ramakanth A. Gayakwad, Op-Amps & Linear Integrated Circuits. 2nd ed. 1991, ISBN-10: 0136371744
4. A.P. Malvino and Donald, Principal and Application in Electronics. Tata McGraw-Hill, ISBN : 0070141703
5. Thomas L. Floyd. Digital Electronics. New Delhi: Person, ISBN-13: 978-0132737968
6. A.D. Helfrick and W.D. Cooper, Modern electronics Instrumentation and Measurements Techniques, New Delhi: PHI, ISBN: 978-81-317-0888-0
7. J. D. Rayder, Fundamental of electronics, ISBN-13: 978-8120300828

1. Name of the Department: Physics						
2. Course Name	**Analog and Digital Communication**	**L**	**T**		**P**	
3. Course Code	17080308	0	0		4	
4. Type of Course (use tick mark)		**Core ()**	**DSE (√)**		**SEC ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 0		**Tutorials = 0**	**Practical = 52**			

8. Course Description:

Through this course students will gain practical knowledge about modulation and demodulation of the signals using techniques like AM, FM, PAM, PPM, PWM, etc.

9. Course Objectives:

1. To study amplitude modulated (AM) and frequency modulated signals.
2. To study demodulation of amplitude modulated (AM) signals.
3. To determine modulation index in amplitude modulation.
4. To study the characteristics of multivibrators

10. Course Outcomes (COs):

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

Correlate the theoretical concepts of Analog and Digital Communication and identify its practical applications through experiment procedure and results.

11. List of Experiments

i. Study of linear and square wave detector.

ii. Generation of amplitude modulated (AM) signals.

iii. To study the demodulation of amplitude modulated (AM) signals.

iv. To study the generation and detection of frequency modulated (FM) signals.

v. To observe the effect of modulation index in amplitude modulation.

vi. To understand the demodulation of an frequency modulated (FM) signals.

vii. Study of super heterodyne receiver.

viii. To study pulse amplitude, Pulse width and Pulse position modulations.

ix. To study the frequency response of an operational amplifier.

x. To study the characteristics of multivibrators – bistable, Astable, monostable.

Note: The list of the experiment given above should be considered as suggestive of the standard and available equipment. The faculty members are authorised to add or delete from this list whenever considered necessary.

12. Book Recommended:

1. R. A. Dunlup. Experimental Physics: Modern Methods. New Delhi: Oxford University Press, ISBN-0195049497
2. B. K. Jones. Electronics for Experimentation and Research. Prentice-Hall, ISBN 13: 9780132507547

Condensed Matter Physics

1. Name of the Department: Physics						
2. Course Name	**Basic Concepts in Condensed Matter Physics**	**L**	**T**		**P**	
3. Course Code	17080309	3	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE (√)**		**SEC ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 40		**Tutorials** = 0		**Practical** = 0		

8. Course Description:

This course intends to provide knowledge about the basic elements of condensed matter physics.

9. Course Objectives:

1. This course imparts knowledge about conceptual condensed matter physics.
2. This course aims to provide a general introduction to theoretical concepts in condensed matter physics.
3. This course aims to provide an introduction to the experimental topics in condensed matter physics.
4. This course aims to set a correlation between the academic and investigational studies.

10. Course Outcomes (COs):

1.The students will be able to apply the theoretical concepts of X-ray diffraction in crystals experimentally

2.Students will be able to explain and differentiate between the metals, insulators and semiconductors based upon the knowledge of band theory

3.Students will be able to understand the thermal properties of the solids and calculate the specific heats of the solids.

4.Based upon the theoretical concepts, students can calculate the crystal energies and analyze the types of bonding

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Crystal Lattices**

Diffraction of electromagnetic waves by crystals: X-rays, Electrons and Neutrons, Symmetry operations and classification of Bravais lattices, common crystal structures, reciprocal lattice, Brillouin zone, X-ray diffraction, Bragg's law, Von Laue's formulation, diffraction from non-crystalline systems. Geometrical factors of SC, FCC, BCC and diamond lattices; Basis of quasi crystals.

Unit – 2	**Number of lectures = 10**	**Title of the unit: Crystal Binding and Lattice Dynamics**

Bond classifications – types of crystal binding, covalent, molecular and ionic crystals, London theory of van der Waals, hydrogen bonding, cohesive and Madelung energy.

Failure of the static lattice model, adiabatic and harmonic approximation, vibrations of linear monoatomic lattice, one-dimensional lattice with basis, models of three-dimensional lattices, quantization of lattice vibrations, Einstein and Debye theories of specific heat, phonon density of states,

neutron scattering.		
Unit – 3	**Number of lectures = 12**	**Title of the unit: Metals and Band theory of Solids**
Drude theory, DC conductivity, magneto-resistance, thermal conductivity, thermoelectric effects, Fermi-Dirac distribution, thermal properties of an electron gas, Wiedemann-Franz law, critique of free-electron model. Periodic potential and Bloch's theorem, weak potential approximation, density of states in different dimensions, energy gaps, Fermi surface and Brillouin zones. Origin of energy bands and band gaps, effective mass, tight-binding approximation and calculation of simple band-structures. Motion of electrons in lattices, Wave packets of Bloch electrons, semi-classical equations of motion, motion in static electric and magnetic fields, theory of holes, cyclotron resonance.		
Unit – 4	**Number of lectures = 8**	**Title of the unit: Defects and Diffusion in Solids and Semiconductors**
Point defects: Frenkel defects, Schottky defects, examples of colour centres, line defects and dislocations. General properties and band structure, carrier statistics, impurities, intrinsic and extrinsic semiconductors, drift and diffusion currents, mobility, Hall effect.		
12. Brief Description of self learning / E-learning component		
https://nptel.ac.in/courses/115/105/115105099/ https://www.youtube.com/watch?v=RImqF8z91fU https://www.youtube.com/playlist?list=PL64fZsc8IYkVkb4Uf0esPJ5GUq6g0Og9s		
13. Books Recommended		
1. Introduction to Solid State Physics, Charles Kittel, John Wiley and Sons, ISBN: 978-8126535187 2. Solid State Physics, Neil W. Ashcroft and N. David Mermin, Holt, Rinehart and Winston, ISBN: 978-0030839931 3. Applied Solid State Physics, Rajnikant, Wiley India, ISBN: 9788126522835 4. Solid State Physics, S O Pillai, New Age International Publishers, ISBN: 978-9386070920 5. Elements of Solid State Physics, J P Srivastava, PHI Learning Private Limited, ISBN: 978-81-203-5066-3		

1. Name of the Department: Physics						
2. Course Name	**Basic Concepts in Condensed Matter Physics Lab**	**L**	**T**		**P**	
3. Course Code	17080310	0	0		4	
4. Type of Course (use tick mark)		**Core ()**	**DSE (√)**		**SEC ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 0		**Tutorials = 0**		**Practical = 52**		

8. Course Description:

In this course students will gain practical knowledge about lattice dynamics, band gap and basic concepts of semiconductor devices

9. Course Objectives:

1. The major objective of this course is to make students understand the basic concepts of condensed matter physics through a standard set of experiments.
2. While performing these experiments students must correlate them with the corresponding theory
3. To make students practise thinking and to have hands on experience of the equipment
4. To make student acquire, process, analyse and interpret the data

10. Course Outcomes (COs):

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

1. Distinguish between the type of semiconductors and find their band gap
2. Analyze the mono and di-atomic lattice
3. apply different experimental techniques to calculate scientific parameters
4. correlate the theoretical concepts with the experiments

11. List of Experiments

1. To study Hall effect in semiconductor to determine Hall voltage, concentration of charge carriers and the type of semiconductor etc.
2. To measure the band gap of Germanium using four probe method.
3. Study of dispersion relation for the mono-atomic lattice – comparison with theory.
4. Determination of cut-off frequency of the mono atomic lattice
5. Study of the dispersion relation for the di-atomic lattice – acoustical mode and optical mode energy gap. Comparison with theory.
6. To draw forward and reversed bias characteristics of a semiconductor diode.
7. Zener Diode voltage regulation characteristics.
8. To determine the value of e/m by Thomson's method
9. To determine band gap using van der Paw technique
10. To determine the value of e/m by helical method

Note: The list of the experiment given above should be considered as suggestive of the standard and available equipment. The faculty members are authorised to add or delete from this list whenever considered necessary.

12. Book Recommended:

1. Harnam Singh and P S Hemne, Practical Physics, S Chand, ISBN: 9788121904698
2. R. A. Dunlup. Experimental Physics: Modern Methods. New Delhi: Oxford University Press, 978-0195049497

1. **Name of the Department: Physics**						
2. **Course Name**	**Condensed Matter Physics: Physical Properties**	**L**	**T**		**P**	
3. **Course Code**	17080311	3	0		0	
4. **Type of Course (use tick mark)**		**Core ()**	**DSE (√)**		**SEC ()**	
5. **Pre-requisite (if any)**		6. **Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()
7. **Total Number of Lectures, Tutorials, Practical**						
Lectures = 40		**Tutorials** = 0	**Practical** = 0			
8. **Course Description:**						
This course intends to provide knowledge about the Physical properties of solids.						
9. **Course Objectives:**						
1. This course gives an insight about conceptual condensed matter physics. 2. This course delivers a general outline to theoretical concepts in condensed matter physics. 3. This course provides an introduction to the experimental topics in condensed matter physics. 4. This course aims to set a correlation between the academic and investigational studies.						
10. **Course Outcomes (COs):**						
1.The students will be able to find out about dielectric and ferroelectric materials 2.The student will come to know about the optical properties of solids which play an important role in crystal structure determination 3.Student will know the magnetic parameters and will be able to find potential materials for magnetic applications 4.Hall effect knowledge will make the students to recognize the p- or n-type semiconductors						
11. **Unit wise detailed content**						
Unit-1	**Number of lectures = 8**	**Title of the unit: Dielectric Properties of Solids**				
Dielectrics and ferroelectrics, macroscopic electric field, local field at an atom, dielectric constant and polarizability, ferroelectricity, antiferroelectricity, piezoelectric crystals, ferroelasticity, electrostriction.						
Unit - 2	**Number of lectures = 8**	**Title of the unit: Optical properties**				
Optical constants and their physical significance, Reflectivity in metals, plasmonic properties of metals, determination of band gap in semiconductors: direct and indirect band gap, defect mediated optical transitions, excitons, photoluminescence, Electroluminescence.						
Unit - 3	**Number of lectures = 10**	**Title of the unit: Magnetism**				
Types of magnetic materials, Quantum theory of paramagnetism, Hund's rule, Ferromagnetism, anti-ferromagnetism: molecular field, Curie temperature. Domain theory, Magnetic Anisotropy, Magnetic interactions, Heitler-London method, exchange and super exchange, magnetic moments and crystal-field effects, spin-wave excitations and thermodynamics, anti-ferromagnetism, Magnetostriction.						
Unit - 4	**Number of lectures**	**Title of the unit: Transport Properties of Solids and**				

	= 14	**Superconductors**
Boltzmann transport equation, resistivity of metals and semiconductors, Fermi surfaces – determination, Landau levels, de Hass van Alphen effect, Quantum Hall effect- Integral quantum Hall effect and magnetoresistance. Phenomenology, review of basic properties, thermodynamics of superconductors, London's equation and Meissner effect, Type-I and Type-II superconductors, BCS theory of superconductors.		
12. **Brief Description of self learning / E-learning component**		
https://nptel.ac.in/courses/115/105/115105099/ https://www.youtube.com/watch?v=RImqF8z91fU https://www.youtube.com/playlist?list=PL64fZsc8IYkVkb4Uf0esPJ5GUq6g0Og9s		
13. **Books Recommended**		
1. Introduction to Solid State Physics, Charles Kittel, John Wiley and Sons, ISBN: 978-8126535187 2. Solid State Physics, Neil W. Ashcroft and N. David Mermin, Holt, Rinehart and Winston, ISBN: 978-0030839931 3. Applied Solid State Physics, Rajnikant, Wiley India, ISBN: 9788126522835 4. Solid State Physics, S O Pillai, New Age International Publishers, ISBN: 978-9386070920 5. Elements of Solid State Physics, J P Srivastava, PHI Learning Private Limited, 9789386070920		

1. Name of the Department: Physics						
2. Course Name	**Condensed Matter Physics: Physical Properties Lab**	**L**	**T**		**P**	
3. Course Code	17080312	0	0		4	
4. Type of Course (use tick mark)		**Core ()**	**DSE (√)**		**SEC ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 0		**Tutorials = 0**		**Practical = 52**		

8. Course Description:

In this course students will gain practical knowledge about optical, dielectric and magnetic properties of the materials.

9. Course Objectives:

1. The major objective of this course is to make students understand the basic concepts of condensed matter physics through a standard set of experiments.
2. While performing these experiments students must correlate them with the corresponding theory
3. To make students practise thinking and to have hands on experience of the equipment
4. To make student acquire, process, analyse and interpret the data

10. Course Outcomes (COs):

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

1. calculate various optical parameters
2. calculate the dielectric properties
3. apply different experimental techniques to calculate scientific parameters
4. associate the theoretical concepts with the experiments

11. List of Experiments

1. To determine the variation of the refractive index of the material of prism and to verify Cauchy's dispersion formula.
2. To study the UV/vis spectrum of a given sample.
3. To find the dielectric constant of liquids
4. To study Curie temperature of magnetic materials.
5. Dielectric constant and Curie temperature of ferroelectric ceramics.
6. To Study Hysteresis (B-H curve).
7. Two probe method for resistivity measurement.
8. To study conductivity of thin film by four probe method.
9. To find the magnetoresistance of semiconducting material
10. To determine the change in length of the sample when placed in magnetic field.

Note: The list of the experiment given above should be considered as suggestive of the standard and available equipment. The faculty members are authorised to add or delete from this list whenever considered necessary.

12. Book Recommended:

1. Harnam Singh and P S Hemne, Practical Physics, S Chand, ISBN: 9788121904698

2. R. A. Dunlup. Experimental Physics: Modern Methods. New Delhi: Oxford University Press, 978-0195049497

1. Name of the Department: Physics						
2. Course Name	**Advanced Condensed Matter Physics**	**L**	**T**		**P**	
3. Course Code	17080313	3	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE (√)**		**SEC ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 40		**Tutorials** = 0		**Practical** = 0		

8. Course Description:

This course intends to provide knowledge about the advanced concepts in condensed matter physics

9. Course Objectives:

1. This course intends to provide knowledge of emerging topics in condensed matter physics.
2. In addition, this course aims to provide introduction to theoretical aspects of advanced topics.
3. This course aims to provide an introduction to the experimental topics in condensed matter physics.
4. This course aims at inculcating conceptual know how in students

10. Course Outcomes (COs):

1.The students will have information about the carbon-based materials
2.Student will get basic knowledge about properties of different materials which have a wide range of applications in different spheres.
3.Students will be able to understand the ferroelectric phase transitions of first and second order.
4.The students will be exposed to different characterization techniques used in experimental condensed matter physics.

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Glasses and Polymers**

Glass formation, types of glasses and glass transition, radial distribution function and amorphous semiconductors, electronic structure of amorphous solids, localized and extended states, mobility edges, Density of states and their determination, transport in extended and localized states, Optical properties of amorphous semiconductors. Structure of polymers, polymerization mechanism, characterization techniques, optical, electrical, thermal and dielectric properties of polymers.

Unit – 2	**Number of lectures = 8**	**Title of the unit: Liquid crystals**

Liquid Crystals. Structural peculiarities and applications, Thermotropic liquid crystals; Classification, Phases and phase transitions; anisotropic materials; symmetry aspects; optics; electro-optics of liquid crystals; ferro-, and antiferroelectric liquid crystals; examples of LCs in nanoscience, photonics and microwave electronics, display devices.

Unit – 3	**Number of lectures = 14**	**Title of the unit: Carbon based materials and Phase transitions in solids**

Fullerenes, C60, C80 and C240 Nanostructures; Properties and Applications (mechanical, optical and electrical). CNT-single walled and multiwalled, graphene.

Landau's theory, first order and second order transition, order parameter and critical exponents, examples of phase transition: Solid-liquid, ferroelectric – paraelectric, ferromagnetic – paramagnetic, superconducting transition, liquid crystals.

Unit – 4	**Number of lectures = 8**	**Title of the unit: Introduction to Surface Physics**

Reconstruction and relaxation, surface electronic structure; Hetrostructures; Self-assembled monolayers, Electrified interfaces, Charge transfer at the liquid-solid interfaces. Thin film deposition methods: thermal evaporation and sputtering.

12. Brief Description of self learning / E-learning component

https://nptel.ac.in/courses/118/104/118104008/
https://nptel.ac.in/courses/113/106/113106093/
https://nptel.ac.in/courses/113/107/113107081/
https://nptel.ac.in/courses/118/102/118102003/

13. Books Recommended

1. Physics of Amorphous Solids, R. Zallen (John Wiley and sons, 1983), ISBN: 978-0471299417

2. Introduction to Polymer Physics, Ulrich Eisele and Stephen D. Pask (Springer-Verlag, 2011), ISBN: 978-3642744365

3. The physics of liquid crystals, Pierre-Gilles de Gennes (2nd Ed., Oxford University Press, 2003), ISBN: 9780198520047

4. Introduction to Liquid Crystals, Peter J. Wojtowicz, E. Priestly, Ping Sheng (Plenum press, 1975), ISBN: 9780306308581

5. The Physics of Phase Transitions - Concepts and Applications, P. Papon, J. Leblond, and Paul H. E. Meijer (2nd Ed., Springer-Verlag, 2006), ISBN: 978-3-540-33390-6

1. Name of the Department: Physics							
2. Course Name	**Advanced Condensed Matter Physics Lab**	**L**	**T**		**P**		
3. Course Code	17080314	0	0		4		
4. Type of Course (use tick mark)		**Core ()**	**DSE (√)**		**SEC ()**		
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()	
7. Total Number of Lectures, Tutorials, Practical							
Lectures = 0		**Tutorials = 0**	**Practical = 52**				

8. Course Description:

In this course students will gain practical knowledge advanced experiments related to condensed matter physics

9. Course Objectives:

1. The major objective of this course is to make students understand the basic concepts of condensed matter physics through a standard set of experiments.
2. While performing these experiments students must correlate them with the corresponding theory
3. To make students practise thinking and to have hands on experience of the equipment
4. To make student acquire, process, analyse and interpret the data

10. Course Outcomes (COs):

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

1. Distinguish between the crystal structures
2. Calculate various lattice parameters
3. Understand the thermal phenomena in materials
4. associate the theoretical concepts with the experiments

11. List of Experiments

1. To measure the Curie Temperature of a given ferroelectric material.
2. Structural characterization of nanomaterials by XRD- determination of average grain size, lattice parameters, strains etc.
3. Thermal characterization of polymers by DSC/DTA technique.
4. Structural characterization of Glass/Polymer by XRD
5. Thermal characterization of Glasses by DSC/DTA technique.
6. Synthesis of nanoparticles.
7. To study the photodiode characteristics.
8. To find the crystal structure of the nanomaterials
9. Generate a Bravais lattice in Matlab
10. Generate and visualize Wigner Seitz primitive cell in Matlab
11. Plot cubic lattice and a plane with the Miller indices (1, 1, 1).

Note: The list of the experiment given above should be considered as suggestive of the standard and available equipment. The faculty members are authorised to add or delete from this list whenever considered necessary.

12. Book Recommended:

1. Nanoscale Characterization of Surfaces & Interfaces, N John Dinardo, (Weinheim Cambridge: Wiley-VCH, 2000) ISBN: 9783527292479.
2. Vyazovkin, Sergey & Koga, Nobuyoshi & Schick, Christoph. (2018). Handbook of Thermal Analysis and Calorimetry, v.6, Recent Advances, Techniques and Applications., ISBN: 978-0-444-64062-8

Nuclear Physics

1. Name of the Department: Physics						
2. Course Name	Nuclear Physics	**L**	**T**		**P**	
3. Course Code	17080315	3	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE(√)**		**ASE()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 40		**Tutorials = 0**	**Practical = 0**			
8. Brief Syllabus						
The syllabus is divided into four units i.e. Nuclear Properties, Nuclear Forces, Radioactive decays and Elementary Particles.						
9.Course objectives:						
The course develops an understanding of theoretical and experimental approaches for nuclear Properties, forces between nucleons via two nucleon problem. Also this course provide a hand on Radioactive decay and Physics of elementary Particles.						
10. Course Outcomes (COs):						
After the successful completion of the course, students will be able to 1. Explain the concepts of Nuclear properties, forces, Radioactive decays and elementary particles in detail. 2. Understand approaches used in research in the field of Experimental and theoretical Nuclear Physics. 3. Use their knowledge in Analytical/Scientific Reasoning in the area of Nuclear Physics. 4. Apply their knowledge in solving problems.						
11. Unit wise detailed content						
Unit-1	**Number of lectures = 10**	**Title of the unit: Nuclear Properties**				
Nuclear mass, Nuclear radii measurements – Scattering and Electromagnetic method, Nuclear electric and magnetic moments, Quantum properties of nuclear states, Binding energies, Semi empirical mass formula. Liquid drop model, Outlines of Bohr and Wheeler theory.						
Unit - 2	**Number of lectures = 10**	**Title of the unit: Nuclear Forces**				
Nuclear Forces, Two-nucleon interaction potential, the Deuteron Problem, Ground and excited states of Deuteron, Neutron-Proton (n-p) scattering at low energies, Effective range theory in n-p scattering. Coherent and Incoherent scattering, Tensor forces and the Deuteron Problem, Proton-Proton (p-p) scattering at low energy. Comparison between n-p and p-p scattering.						
Unit - 3	**Number of lectures = 10**	**Title of the unit: Radio Active Decays**				
Alpha Decay and its Kinematics, Range, Geiger-Nuttal law, Gamow's theory of alpha decay. Beta decays, Energy relations, Fermi theory of beta decay, Beta transitions, selection rules, Parity violation, Wu-Ambler experiment, Helicity of electron and neutrino. Gamma Decay, Electric and Magnetic multipole gamma transitions, selection rules, Internal Conversion process, Transition rates, Directional correlation in gamma emission.						
Unit - 4	**Number of lectures = 10**	**Title of the unit: Elementary Particles (10)**				

1. Name of the Department: Physics						
2. Course Name	**Nuclear Physics Lab**	**L**	**T**		**P**	
3. Course Code	17080316	0	0		4	
4. Type of Course (use tick mark)		**Core ()**	**DSE (√)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 0		**Tutorials = 0**	**Hours = 52**			

8. Course Description:

In this course student will hand on the experiments using weak radioactive sources, G.M. counters, Scintillation Counters, MCA, SCA, DAC and CRO.

9. Course Objectives:

The course aims to provide students with a practical knowledge of the particles identification, basic electronics behind nuclear techniques and radiation and Particle detectors.

10. Course Outcomes (COs):

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

1. Understand and describe the particle Identification.
2. Understand and demonstrate the experimental knowledge in laboratory.
3. Analyse scientific data available from the experiments and explain.
4. Improve their research related skills.

11. List of Experiments

1. To study the variations of count rate with applied voltage and thereby determine the plateau, the operating voltage and the slope of Plateau.
2. Measurement of dead time.
3. To investigate the statistics related to measurements with a Geiger counter – Poisson Distribution
4. To investigate the statistics related to measurements with a Geiger counter- Gaussian Distribution
5. To find the absorption coefficient of given material using G.M. counter and deduce end-point energy of a beta emitter.
6. To study the absorption of Beta particles in different materials.
7. Source strength of a Beta Source.
8. To study the Back scattering of Beta particles.
9. To study Production and attenuation of Bremstrhlung.
10. Measurement of Short Half life.

Note: The list of the experiment given above should be considered as suggestive of the standard and available equipment. The faculty members are authorised to add or delete from this list whenever considered necessary.

12. Books Recommended:

1. Techniques in Nuclear and particle Experiments by W.R. Leo (Springer), 1994. ISBN-978-3540572800
2. Radiation detection and measurement by Glenn F. Knoll (Wiley), 2010. ISBN: 978-0-470-13148-0
3. Introduction to Experimental Particle Physics by Richard Fernow (Cambridge University Press), 2001. ISBN-978-0511622588

Fundamental Forces, Elementary particles and their quantum numbers (charge, spin, parity, isospin, strangeness, etc.), Symmetries and Conservation laws. Gellmann-Nishijima formula. Quark model, Baryons and Mesons. C, P and T invariance. Application of symmetry arguments to particle reactions. Parity non-conservation in Weak interaction. Relativistic Kinematics.

12. Brief Description of self- learning / E-learning component.

To understand basic concepts in detail, students may get study materials on these links.

1. https://onlinecourses.nptel.ac.in/noc18_ph02
2. https://www.mooc-list.com/tags/nuclear-physics
3. www.nuclearonline.org/Courses.htm
4. https://study.com/directory/category/Physical_Sciences/Physics/Nuclear_Physics.html
5. https://www.class-central.com/tag/nuclear%20physics

13. Books Recommended

1. R. R. Roy and B. P. Nigam, "Nuclear Physics: Theory and Experiment", New Age International Pvt Ltd (1 January 2014). ISBN-978-8122434101
2. D.C. Tayal, "Nuclear Physics", Himalaya Publishing House, 2009 ISBN-13: 978-9350247433
3. W. E. Burcham, "Nuclear Physics : An Introduction", Longman Group Limited, London, 1973. ISBN-978-0582441101
4. R. G. Sachs, "Nuclear Theory", Addison-Wesley Publishing Company, Cambridge, 1955. ISBN-978-0201067002
5. K. S. Krane, "Introductory Nuclear Physics", Wiley India Pvt. Ltd., 2008 ISBN-978-8126517855
6. Introduction to High Energy Physics : D.H. Perkins (Cambridge University Press), 4th ed. 2000. ISBN- 978-0511809040
7. Introduction to Particle Physics : M.P. Khanna (Prentice Hall of India, New Delhi), 2004. ISBN-978-8120312685

1. Name of the Department: Physics						
2. Course Name	Advanced Nuclear Physics: Structure and Reactions	**L**	**T**		**P**	
3. Course Code	17080317	3	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE(√)**		**ASE()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 40		**Tutorials = 0**				

8. Brief Syllabus:

The course is divided into four units i.e. Nuclear shell model, collective model, Advanced Nuclear Structure, nuclear reactions.

9.Course objectives:

The course aims to provide students an understanding of advancements in Nuclear Physics research. The course explains the development of nuclear structure and nuclear reactions using theoretical approaches and experimental data.

10. Course Outcomes (COs):

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

1. Explain comprehensively about the various nuclear models and nuclear reactions.
2. Understand experimental and theoretical approaches used in research in the field of Nuclear Physics.
3. Use their knowledge in Analytical/Scientific Reasoning in the area of Nuclear Physics.
4. Understand the present scenario in the field of Nuclear Physics.

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Nuclear Shell Model**

Evidence for nuclear shell structure, Extreme single particle model, Shell model predictions. Single-particle model, Nuclear isomerism, Magnetic moment-Schmidt lines, Electric quadrupole moment, Configuration mixing, Independent particle model, L-S coupling and J-J coupling.

Unit - 2	**Number of lectures = 12**	**Title of the unit: Collective Model**

Rotation-D matrices and properties, Collective modes of motion, Nuclear vibrations, iso-scalar vibrations, Giant resonance, Parameterization of nuclear surface, Derivation of the collective Hamiltonian, Deformed rotational nuclei, Rotational energy spectra for even-even nuclei and odd-A nuclei, Electric quadrupole moment, Magnetic dipole moment, Energy spectrum with coupling of vibration and rotational motion.

Unit - 3	**Number of lectures = 8**	**Title of the unit: Advanced Nuclear Structure**

Harmonic anisotropic oscillator, Nilsson model, Rotational motion at very high spins, Cranking shell model, Kinematics and Dynamic moment of inertia, Back-bending phenomenon.
Brief review - Nuclear Physics at extremes of stability.

Unit - 4	**Number of lectures = 10**	**Title of the unit: Nuclear Reaction**

Nuclear Reaction Cross sections, Breit-Wigner dispersion formula, the Compound nucleus, Continuum theory of cross section, Statistical theory of Nuclear Reaction. Optical model for nuclear reactions at low energies, Comparison with experiments. Direct Reactions - Kinematics of stripping and pick-up reactions, theory of stripping and pick-up reactions.

11. Brief Description of self-learning / E-learning component:

To understand basic concepts in detail, students may get study materials on following links.

1. https://onlinecourses.nptel.ac.in/noc18_ph02
2. https://www.mooc-list.com/tags/nuclear-physics
3. www.nuclearonline.org/Courses.htm
4. https://study.com/directory/category/Physical_Sciences/Physics/Nuclear_Physics.html
5. https://www.class-central.com/tag/nuclear%20physics

13. Books Recommended

1. R. R. Roy and B. P. Nigam, "Nuclear Physics: Theory and Experiment", New Age International Pvt Ltd (1 January 2014). ISBN-978-8122434101.
2. M. K. Pal, "Theory of Nuclear Structure", Affiliated East-West Press, New Delhi. ISBN-978-8185336817.
3. Basic Ideas and Concepts in Nuclear Physics: K. Heyde, (Overseas Press India) (2005). ISBN-978-0750309806.
4. Elementary theory of Angular momentum: M.E. Rose (Dover edition) (1995). ISBN-978-0486684802.
5. Nuclear Physics: Experimental and Theoretical: H. S. Hans, New Age International Pvt Ltd (1 January 2019) ISBN-978-8122431414

1. Name of the Department: Physics						
2. Course Name	**Advanced Nuclear Physics Laboratory**	**L**	**T**		**P**	
3. Course Code	17080318	0	0		4	
4. Type of Course (use tick mark)		**Core ()**	**DSE (√)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures =		**Tutorials =**	**Practical = 52**			

8. Course Description:

In this course student will hand on the experiments using weak radioactive sources, G.M. counters, Scintillation Counters, MCA, SCA, DAC and CRO.

9. Course Objectives:

The course aims to provide students with a practical knowledge of the particles identification, basic electronics behind nuclear techniques and Radiation and particle detector.

10. Course Outcomes (COs):

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

1. Understand and describe the particle Identification.
2. Understand and demonstrate the experimental knowledge in laboratory.
3. Analyse scientific data available from the experiments and explain.
4. Improve their research related skills.

11. List of Experiments

1. To find the operating voltage of GM Tube
2. Window thickness of a G.M. Tube.
3. To distinguish between beta and gamma radiation using GM Tube
4. To estimate the efficiency for a gamma Source.
5. To estimate the efficiency for Beta Source.
6. To Study the inverse square Law.
7. To determine the range of beta particle and maximum energy using Half thickness method.
8. To study the alpha spectrum from natural sources Th and U.
9. To determine the gamma-ray absorption coefficient for different elements.
10. To calibrate the given gamma-ray spectrometer and determine its energy resolution.

Note: The list of the experiment given above should be considered as suggestive of the standard and available equipment. The faculty members are authorised to add or delete from this list whenever considered necessary.

12. Books Recommended:

1. Techniques in Nuclear and particle Experiments by W.R. Leo (Springer), 1994. ISBN-978-3540572800
2. Radiation detection and measurement by Glenn F. Knoll (Wiley), 2010. ISBN: 978-0-470-13148-0
3. Introduction to Experimental Particle Physics by Richard Fernow (Cambridge University Press), 2001. ISBN-978-0511622588

1. Name of the Department: Physics						
2. Course Name	Experimental techniques in Nuclear Physics	**L**	**T**		**P**	
3. Course Code	17080319	3	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE(√)**		**ASE()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 40		**Tutorials = 0**				

8. Brief Syllabus:

The course is divided into four units i.e. Data interpretation and analysis, radiation and particle detectors, electronics associated with detectors and particle accelerators and facilities in India.

9. Course Objectives:

The aim and objective of the course is to make a ground for students to work in experimental research in the field of Nuclear Physics. In this course students are given exposure to theoretical and experimental aspects of different equipment and methods used in the experimentation.

10. Course Outcomes (COs):

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

1. Understand and explain various experimental techniques used in Nuclear Physics research.
2. Use the knowledge of detectors and associated electronics.
3. Understand the developments and challenges in detection systems and particle accelerators.
4. Understand the Analytical and Scientific Reasoning in area of experimental Nuclear Physics.
5. Know the particle accelerators and facilities available in India.

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Data Interpretation and analysis**

Precision and accuracy, Error analysis, Statistical treatment of experimental data. Least squares fitting of linear and nonlinear functions, Chi square test, Binomial, Poisson and Gaussian distributions, Lorentzian distributions. Review on Detection of radiations: Interaction of gamma-rays, neutrons, electrons and heavy charged articles with matter, Relativistic particle interaction.

Unit - 2	**Number of lectures = 10**	**Title of the unit: Radiation and Particle detectors**

General properties of Radiation detectors: Energy resolution, Detection efficiency and Dead time. Statistics and treatment of experimental data. Gas-filled detectors: Proportional counters, G.M. Counter, Position-sensitive proportional counters, Multiwire proportional chambers, Drift chamber, Time projection chamber.

Organic and Inorganic scintillators and their characteristics, Description of electron and gamma ray spectrum from detector, Cherenkov detector.

Semiconductor detectors in X- and Gamma-ray spectroscopy, Ge, Si(Li) and SDD detectors, Compton-suppressed Ge detectors, Semiconductor detectors for charged particle spectroscopy and particle identification, Silicon Strip detectors, General Background and detector shielding.

Unit - 3	**Number of lectures = 10**	**Title of the unit: Electronics associated with detectors**

Electronic shielding and grounding, Measurement and control, Signal conditioning and recovery. Electronics for pulse signal processing, Preamplifiers (voltage and charge-sensitive configurations), Linear amplifiers, CR-$(RC)_n$ and Delay-line pulse shaping, Pole-zero cancellation, Baseline shift and restoration, Overload recovery and pileup, Impedance matching, Single-channel and Multichannel analysers

Unit - 4	**Number of lectures = 10**	**Title of the unit: Particle Accelerators and facilities in India**

Van-de Graff generator, Cyclotron, Linear accelerator, Pelletron, Synchrotron, Production of Radioactive Ion beams. Detector systems for Heavy-Ion reactions: Large gamma and charge particle detector arrays, Multiplicity filters, Electron spectrometer, Heavy-Ion reaction analyzers, Nuclear lifetime measurements (DSAM and RDM techniques).

12. Brief Description of self-learning / E-learning component:

To understand basic concepts in detail, students may get study materials on following links.

1. https://onlinecourses.nptel.ac.in/noc18_ph02
2. https://www.mooc-list.com/tags/nuclear-physics
3. www.nuclearonline.org/Courses.htm
4. https://study.com/directory/category/Physical_Sciences/Physics/Nuclear_Physics.html
5. https://www.class-central.com/tag/nuclear%20physics

13. Books Recommended

1. Techniques in Nuclear and particle Experiments by W.R. Leo (Springer), 1994. ISBN-978-3540572800
2. Radiation detection and measurement by Glenn F. Knoll (Wiley), 2010. ISBN: 978-0-470-13148-0
3. Introduction to Experimental Particle Physics by Richard Fernow (Cambridge University Press), 2001. ISBN-978-0511622588
4. Detectors for particle radiation by Konrad Kleinknecht(Cambridge University Press), 1999. ISBN: 9780521648547

1. Name of the Department: Physics						
2. Course Name	**Experimental techniques in Nuclear Physics Lab**	**L**	**T**		**P**	
3. Course Code	17080320	0	0		4	
4. Type of Course (use tick mark)		**Core ()**	**DSE (√)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 0		**Tutorials =0**	**Practical = 52**			

8. Course Description:

In this course student will hand on the experiments using weak radioactive sources, G.M. counters, Scintillation Counters, MCA, SCA, DAC and CRO.

9. Course Objectives:

The course aims to provide students with a practical knowledge of the particles identification, basic electronics behind nuclear techniques and radiation and Particle detectors.

10. Course Outcomes (COs):

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

1. Understand and describe the particle Identification.
2. Understand and demonstrate the experimental knowledge in laboratory.
3. Analyse scientific data available from the experiments and explain.
4. Improve their research related skills.

11. List of Experiments

1. To determine the plateau, and find the operating voltage of GM tube
2. Calibration of Scintillation Spectrometer.
3. Pulse-Height Analysis of Gamma Ray Spectra.
4. To trace the signal of particle detection in a scintillator using CRO.
5. Least square fitting of a straight line.
6. To determine the range of Alpha-particles in air at different pressures and energy loss in thin foils.
7. To determine strength of alpha particles using Solid state nuclear track detector (SSNTD).
8. Study of Compton Scattering Effect.
9. To study p-p interaction and find the cross-section of a reaction using a bubble chamber.
10. To study n-p interaction and find the cross-section using a bubble chamber.

Note: The list of the experiment given above should be considered as suggestive of the standard and available equipment. The faculty members are authorised to add or delete from this list whenever considered necessary.

12. Books Recommended:

1. Techniques in Nuclear and particle Experiments by W.R. Leo (Springer), 1994. ISBN-978-3540572800
2. Radiation detection and measurement by Glenn F. Knoll (Wiley), 2010. ISBN: 978-0-470-13148-0
3. Introduction to Experimental Particle Physics by Richard Fernow (Cambridge University Press), 2001. ISBN-978-0511622588

Semester-IV

1. Name of the Department: Physics						
2. Course Name	**Electronics**	**L**	**T**		**P**	
3. Course Code	17080402	**4**	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE (√)**		**SEC ()**	
5. Pre-requisite (if any)	Physics at graduation level	**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 52		**Tutorials = 0**	**Practical = 0**			

8. Course Description:

The course is intended to provide an understanding of the semiconductor devices used in the current semiconductor industry. It caters to undergraduate and graduate students with a diverse background in Materials Science, and Physics. The course provides the students with the basic physics behind semiconductor materials, types of semiconductors, and the reason for the dominance of silicon in the electronics industry. The course also covers the basics of devices with emphasis on their electronic characteristics. Optical devices like LEDs, lasers, solar cells, and their properties will also be explained.

9. Course Objectives:

1. To study the basics of electronic components
2. To study the basic concept and characteristics of electronic devices and circuits.
3. To observe the characteristics of optical devices like LED, lasers and Solar cells
4. To get familiar with the different number systems and logic gates
5. To study the basics of microprocessor

10. Course Outcomes (COs):

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

1. Apply the concept of semiconductor physics.
2. Apply the concepts of basic electronic devices to design various electronic circuits.
3. Understand operation of diodes, transistors in order to design basic and advanced circuits.
4. Analyze electronic circuits designed using operational amplifiers (Op-Amp).
5. Understand the working principle and uses of microprocessors.

11. Unit wise detailed content

Unit-1	**Number of lectures = 14**	**Title of the unit: Basic Semiconductor Devices**

P-N junction diode, Capacitance of p-n junctions, switching diodes, Clippers & Clampers, Photoconductors, photodiode, light emitting diodes and liquid crystal display, Junction Field Effect Transistor (JFET) : Basic structure & Operation, pinch off voltage, Single ended geometry of JFET, Volt Ampere characteristic, Transfer Characteristics, JFET as Switch and Amplifier. MOSFET: Enhancement MOSFET, Threshold Voltage, Depletion MOSFET, comparison of p & n Channel FET, SCR, 4-layer pnpn devices, Tunnel diode

Unit - 2	**Number of lectures = 14**	**Title of the unit: Digital Electronics**

Various Number system and their arithmetic: binary number system, 2's compliment, Octal number system, hexadecimal number system, BCD codes, Excess-3 codes, Gray codes, Octal codes, Hexadecimal codes and ASCII codes: Digital (binary) operation of a system, Logic system, the OR gate, the AND gate, the NOT gate, the exclusive OR gate, De Morgan's laws, the NAND and NOR diode- transistor gates, transistor-transistor logic (TTL) gates output stages, Digital MOSFET circuits, complementary MOS (CMOS) logic gates, Boolean Algebra, comparison of logic families, Karnaugh-map (K-map) up to four variables and its applications.

Unit – 3	**Number of lectures = 12**	**Title of the unit: Operational Amplifier**

Differential Amplifier, Inverting & non-inverting Amplifiers, Negative and Positive Feedback. Band width,Voltage follower. CMRR, DC, AC, Summing, Scaling & Instrumentation Amplifier, Integrator & Differentiator, Comparator, Oscillator principal and Types, Frequency response and Frequency stability, Phase shift Oscillator

Unit - 4	**Number of lectures = 12**	**Title of the unit: Micro-processor**

Microcomputer systems and Hardware., Microprocessor architecture and Microprocessor system, Instruction and timing diagram, Introduction to 8085 basic instructions, Arithmetic operation, logic operation, branch operation, 16 bit arithmetic instructions., Arithmetic operation related to memory, Rotate and compare instructions, Stack and subroutines, programming of 8085 using instructions, Introduction to Microcontroller

12. Brief Description of self-learning / E-learning component

For understanding the basic concepts in detail, students may get the study materials from these E-learning links

https://ocw.mit.edu/courses/physics/

https://nptel.ac.in/courses/117107094/

https://www.youtube.com/watch?v=CeD2L6KbtVM

13. Books Recommended

1. J. Millman and C. C. Halkies, Integrated Electronics. Tata McGraw-Hill, ISBN: 978-0-07-462245-2.
2. R. P. Jain. Modern Digital Electronics, Tata McGraw Hills, ISBN: 9780070669116
3. Malvino and Leach, Digital Electronics, ISBN- 978-0-07-014170-4
4. S. M. Sze, Semiconductor Devices: Physics and Technology, ISBN-13: 978-8126516810
5. Ramakanth A. Gayakwad, Op-Amps & Linear Integrated Circuits. 2nd ed, ISBN-13: 978-8120320581
6. A.P. Malvino and Donald, Principal and Application in Electronics. Tata McGraw-Hill, ISBN : 0070141703
7. J. D. Rayder, Fundamental of electronics, ISBN-13: 978-8120300828

1. Name of the Department: Physics						
2. Course Name	**Electronics Lab**	**L**	**T**		**P**	
3. Course Code	17080403	0	0		2	
4. Type of Course (use tick mark)		**Core ()**	**DSE (√)**		**SEC ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 0		**Tutorials = 0**	**Practical = 26**			

8. Course Description:

In this course students will gain practical knowledge about various semiconductor and optoelectronic deviceslike JFET, MOSFET, LEDetc and use of op amp for different arithmetic operations.

9. Course Objectives:

To study the characteristics of JFET, MOSFET, Solar cell

To use op amp for different arithmetic operations, square, ramp generator and Wein bridge oscillator

10. Course Outcomes (COs):

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

Correlate the theoretical concepts and identify its practical applications through experiment procedure and results.

11. List of Experiments

1. To study the characteristics of Junction Field Effect Transistor.
2. To study the characteristics of Metal Oxide Semiconductor Field Effect Transistor
3. To study the characteristics of SCR and its application as a switching device.
4. To use Op-Amp for different Arithmetic Operations.
5. To study the characteristics of UJT.
6. To study the characteristics of a solar cell and calculate its fill factor.
7. To design an (i) inverting amplifier and (ii) non-inverting amplifier, of a given gain using operational amplifier.
8. To use Op-Amp as Full Wave Rectifier.
9. To study the characteristics of optoelectronics Devices (LED, photo-detector).
10. To design combinational Logic Circuits using logic gates.

Note: The list of the experiment given above should be considered as suggestive of the standard and available equipment. The faculty members are authorised to add or delete from this list whenever considered necessary.

12. Book Recommended:

1. R. A. Dunlup. Experimental Physics: Modern Methods. New Delhi: Oxford University Press, ISBN-0195049497
2. B. K. Jones. Electronics for Experimentation and Research. Prentice-Hall, ISBN 13: 9780132507547

1. Name of the Department: Physics						
2. Course Name	**Condensed Matter Physics: Basics**	**L**	**T**		**P**	
3. Course Code	17080404	4	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE (√)**		**SEC ()**	
5. Pre-requisite (if any)	Physics at graduation level	**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 52		**Tutorials = 0**		**Practical = 0**		

8. Course Description:

This course will deepen your understanding of the different types of crystal structures, lattice dynamics and band structure of the solids.

9. Course Objectives:

1. This course imparts knowledge about conceptual condensed matter physics.
2. This course aims to provide a general introduction to theoretical concepts in condensed matter physics.
3. This course aims to provide an introduction to the experimental topics in condensed matter physics.
4. This course aims to set a correlation between the academic and investigational studies.

10.Course Outcomes (COs):

After successful completion of the course, students will

1. have a basic knowledge of crystal systems and spatial symmetries
2. be able to understand the lattice dynamics and thermal properties of solids
3. be able to calculate electrical properties in the free-electron model
4. be able to understand the formation of bands and distinguish between metals, insulators and semiconductors

11.Unit wise detailed content

Unit-1	**Number of lectures = 14**	**Title of the unit: Crystal Structure**

Bravais lattice, Primitive vectors, Primitive, conventional and Wigner-Seitz unit cells, Crystal structures and lattices with basis, Lattice planes and Miller indices, Simple crystal structures- Sodium chloride, Cesium chloride, Diamond, and Zinc-blende structures, Determination of crystal structure by diffraction, Reciprocal lattice and Brillouin zones (examples of sc, bcc and fcc lattices), Bragg and Laue formulations of X-ray diffraction by a crystal and their equivalence, Laue equations, Ewald construction, atomic structure factors, Experimental methods of structure analysis: Types of probe beam, the Laue, rotating crystal and powder methods.

Unit – 2	**Number of lectures = 14**	**Title of the unit: Lattice dynamics and thermal properties**

Classical theory of lattice vibration (harmonic approximation), Vibrations of crystals with monatomic basis-Dispersion relation, First Brillouin zone, Group velocity, Two atoms per primitive basis-acoustical and optical modes; Quantization of lattice vibration: Phonons, Phonon momentum, Inelastic scattering of neutrons by phonons; Thermal properties: Lattice (phonon) heat capacity, Normal modes, Density of states in one and three dimensions, Models of Debye and Einstein.

Unit – 3	**Number of lectures = 10**	**Title of the unit: Free electron gas**

Free electron gas model in three dimensions: Density of states, Fermi energy, Effect of temperature, Heat capacity of the electron gas, Experimental heat capacity of metals, Thermal effective mass, Electrical conductivity and Ohm's law, Hall effect; Failure of the free electron gas model

Unit – 4	**Number of lectures = 14**	**Title of the unit: Band Theory**

Periodic potential and Bloch's theorem, Kronig-Penney model, Wave equation of electron in a periodic potential, Solution of the central equation, Approximate solution near a zone boundary, Periodic, extended and reduced zone schemes of energy band representation, Number of orbitals in an energy band, Classification into metals, semiconductors and insulators.

12.Brief Description of self-learning / E-learning component

For understanding the basic concepts in detail, students may get the study materials from these E-learning links

https://ocw.mit.edu/courses/physics/

https://nptel.ac.in/courses/115105099/

https://nptel.ac.in/courses/115104109/

13.Books Recommended

1. Introduction to Solid State Physics, Charles Kittel, John Wiley and Sons, ISBN: 978-8126535187
2. Solid State Physics, Neil W. Ashcroft and N. David Mermin, Holt, Rinehart and Winston, ISBN: 978-0030839931
3. Applied Solid State Physics, Rajnikant, Wiley India, ISBN: 9788126522835
4. Solid State Physics, S O Pillai, New Age International Publishers, ISBN: 978-9386070920
5. Elements of Solid State Physics, J P Srivastava, PHI Learning Private Limited, ISBN: 978-81-203-5066-3

1. Name of the Department: Physics						
2. Course Name	**Condensed Matter Physics: Basics Lab**	**L**	**T**		**P**	
3. Course Code	17080405	0	0		2	
4. Type of Course (use tick mark)		**Core ()**	**DSE (√)**		**SEC ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 0		**Tutorials = 0**		**Practical = 26**		

8. Course Description:

In this course students will gain practical knowledge about lattice dynamics, band gap and basic concepts of semiconductor devices

9. Course Objectives:

1. The major objective of this course is to make students understand the basic concepts of condensed matter physics through a standard set of experiments.
2. While performing these experiments students must correlate them with the corresponding theory
3. To make students practise thinking and to have hands on experience of the equipment
4. To make student acquire, process, analyse and interpret the data

10.Course Outcomes (COs):

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

1. Distinguish between the type of semiconductors and find their band gap
2. to understand the lattice dynamics
3. associate the theoretical concepts with the experiments
4. apply different experimental techniques to calculate scientific parameters

11.List of Experiments

1. To study Hall effect in semiconductor to determine Hall voltage, concentration of charge carriers and the type of semiconductor etc.
2. To measure the band gap of Germanium using four probe method.
3. Study of dispersion relation for the mono-atomic lattice – comparison with theory.
4. Determination of cut-off frequency of the mono atomic lattice
5. Study of the dispersion relation for the di-atomic lattice – acoustical mode and optical mode energy gap. Comparison with theory.
6. To determine the value of e/m by Thomson's method
7. To determine band gap using van der Paw technique
8. To determine the value of e/m by helical method
9. To study conductivity of thin film by four probe method.
10. Two probe method for resistivity measurement.

Note: The list of the experiment given above should be considered as suggestive of the standard and available equipment. The faculty members are authorised to add or delete from this list whenever considered necessary.

12.Book Recommended:

1. Harnam Singh and P S Hemne, Practical Physics, S Chand, ISBN: 9788121904698
2. R. A. Dunlup. Experimental Physics: Modern Methods. New Delhi: Oxford University Press, 978-0195049497

1. Name of the Department: Physics						
2. Course Name	Introductory Nuclear Physics	**L**	**T**		**P**	
3. Course Code	17080406	4	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE(√)**		**ASE()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical		
Lectures = 52	**Tutorials = 0**	**Practical = 0**

8. Brief Syllabus

The syllabus is divided into four units i.e. Nuclear Properties, Nuclear Forces, Nuclear Models and Nuclear reactions.

9.Course objectives:

The course develops an understanding of theoretical and experimental approaches for nuclear Properties, forces between nucleons via two nucleon problem, development of structure of the nucleus and various models for nuclear reactions.

10. Course Outcomes (COs):

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

1. Understand and Explain the concepts of Nuclear properties, forces, models and reactions in detail.
2. Understand approaches used in research in the field of Experimental and theoretical Nuclear Physics.
3. Use their knowledge in Analytical/Scientific Reasoning in area of Nuclear Physics.
4. Apply their knowledge in solving problems.

11. Unit wise detailed content

Unit-1	**Number of lectures = 12**	**Title of the unit: Nuclear Properties**

Nuclear mass, Nuclear radii measurements – Scattering and Electromagnetic method, Nuclear electric and magnetic moments, Quantum properties of nuclear states, Binding energies, Semi empirical mass formula. Liquid drop model, Outlines of Bohr and Wheeler theory.

Unit - 2	**Number of lectures = 14**	**Title of the unit: Nuclear Forces**

Nuclear Forces, The Deuteron Problem, Ground and excited states of Deuteron, Neutron-proton (n-p) scattering at low energies, Scattering length, Spin dependence, singlet state, Effective range theory in n-p scattering. Coherent and incoherent scattering, tensor forces and the deuteron Problem, proton-proton (p-p) scattering at low energy. Comparison between n-p and p-p scattering.

Unit - 3	**Number of lectures = 14**	**Title of the unit: Nuclear Models**

Evidence for nuclear shell structure, Nuclear Shell Model, Extreme single particle model, Square well potential, Harmonic oscillator potential, Spin orbit coupling, Shell model predictions. Nuclear isomerism, Magnetic moment-Schmidt lines, electric quadrupole moment, Configuration mixing, Single particle model and Independent particle model, Nuclear Collective model: Collective modes of motion, Rotational energy spectra for even-even nuclei and odd-A nuclei, Energy spectrum with coupling of vibration and rotational motion.

Unit - 4	**Number of lectures = 12**	**Nuclear Reactions**

Breit-Wigner dispersion formula, the Compound nucleus, Continuum theory of Cross section, Statistical theory of Nuclear Reaction. Optical model for nuclear reactions at low energies, Direct Reactions - Kinematics of stripping and pick-up reactions, Theory of stripping and pick-up reactions.

12. Brief Description of self- learning / E-learning component.

To understand basic concepts in detail, students may get study materials on these links.

1. https://onlinecourses.nptel.ac.in/noc18_ph02
2. https://www.mooc-list.com/tags/nuclear-physics
3. www.nuclearonline.org/Courses.htm
4. https://study.com/directory/category/Physical_Sciences/Physics/Nuclear_Physics.html
5. https://www.class-central.com/tag/nuclear%20physics

13. Books Recommended

1. R. R. Roy and B. P. Nigam, "Nuclear Physics: Theory and Experiment", New Age International Pvt Ltd (1 January 2014). ISBN-978-8122434101
2. D.C. Tayal, "Nuclear Physics", Himalaya Publishing House, 2009 ISBN-13: 978-9350247433
3. M. K. Pal, "Theory of Nuclear Structure", Affiliated East-West Press, New Delhi. ISBN-978-8185336817.
4. Basic Ideas and Concepts in Nuclear Physics: K. Heyde, (Overseas Press India) (2005). ISBN-978-0750309806.
5. K. S. Krane, "Introductory Nuclear Physics", Wiley India Pvt. Ltd., 2008 ISBN-978-8126517855

1. Name of the Department: Physics						
2. Course Name	**Introductory Nuclear Physics Laboratory**	**L**	**T**		**P**	
3. Course Code	17080407	0	0		2	
4. Type of Course (use tick mark)		**Core ()**	**DSE (√)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 0		**Tutorials = 0**	**Hours = 26**			

8. Course Description:

In this course student will hand on the experiments using weak radioactive sources, G.M. counters, Scintillation Counters, MCA, SCA, DAC and CRO.

9. Course Objectives:

The course aims to provide students with a practical knowledge of the particles identification, basic electronics behind nuclear techniques and radiation and Particle detectors.

10. Course Outcomes (COs):

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

1. Understand and describe the particle Identification.
2. Understand and demonstrate the experimental knowledge in laboratory.
3. Analyse scientific data available from the experiments and explain.
4. Improve their research related skills.

11. List of Experiments

1. To study the variations of count rate with applied voltage and thereby determine the plateau, the operating voltage and the slope of Plateau.
2. Measurement of dead time.
3. To investigate the statistics related to measurements with a Geiger counter – Poisson Distribution
4. To investigate the statistics related to measurements with a Geiger counter- Gaussian Distribution
5. To find the absorption coefficient of given material using G.M. counter and deduce end-point energy of a beta emitter.
6. Source strength of a Beta Source.
7. Measurement of Short Half life.
8. Calibration of Scintillation Spectrometer.
9. Pulse-Height Analysis of Gamma Ray Spectra.
10. Least square fitting of a straight line.

Note: The list of the experiment given above should be considered as suggestive of the standard and available equipment. The faculty members are authorised to add or delete from this list whenever considered necessary.

12. Books Recommended:

1. Techniques in Nuclear and particle Experiments by W.R. Leo (Springer), 1994. ISBN-978-3540572800
2. Radiation detection and measurement by Glenn F. Knoll (Wiley), 2010. ISBN: 978-0-470-13148-0
3. Introduction to Experimental Particle Physics by Richard Fernow (Cambridge University Press), 2001. ISBN-978-0511622588

1. Name of the Department: Physics						
2. Course Name	**Advanced Applied Physics**	**L**	**T**		**P**	
3. Course Code	17080408	4	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE(√)**		**OE()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 52		**Tutorials = 0**	**Practical = 0**			

8. Brief Syllabus:

This course will give an introduction to transducer devices, applications of transducer, sensors, detectors, photonics, energy processing, energy storage and conversion systems.

9. Learning objectives:

The aim of this course is to

1. convey knowledge of conceptual physics and its applications including transducers
2. understand the different types of sensors and its applications
3. learn the fundamentals of photonics and its applications in Lasers.
4. understand the energy storage devices and conversion systems.

10.Course Outcomes (COs):

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

1. understand the different types of transducers.
2. understand the construction and working principle of different types of sensors.
3. understand the concepts of photonics and get knowledge of the latest developments in Lasers and their applications.
4. analyze the concept of alternate energy storage devices.

11.Unit wise detailed content

Unit-1	**Number of lectures = 13**	**Title of the unit: Transducers**

Fundamentals of transducer, classifications and general characteristics; displacement transducers, strain gauges, pressure and force transducers, torque transducers, flow transducers, transducers for biomedical applications. Microelectromechanical systems (MEMS), microfabrication and micromachining, advanced lithography techniques, diffusion & ion implantation, and high aspect ratio processes.

Unit – 2	**Number of lectures = 12**	**Title of the unit: Sensors**

Resistive, capacitive, inductive, electromagnetic, thermoelectric, piezoelectric, piezoresistive, photosensitive and electrochemical sensors, toxic gas monitoring, thermal conductivity analyzers, colorimetric determination, sorption type dosimeters, non-dispersive infrared and ultraviolet sensors flame ionisation detector.

Unit – 3	**Number of lectures = 13**	**Title of the unit: Introduction to photonics**

Science of light – evolution, ray/wave/statistical/quantum optics, wave phenomena – interference, diffraction, statistical properties of light – coherence, photons, photon properties - energy, flux, statistics, interaction of photons with atoms, light amplification, laser fundamentals, semiconductor

junction characteristics, semiconductor light sources, semiconductor light detectors.		
Unit – 4	**Number of lectures = 14**	**Title of the unit: Alternate Energy Storage and Harvesting**
Electrochemical energy storage devices - EMF, reversible and irreversible cells, free energy, thermodynamic calculation of the capacity of a battery, calculations of energy and power density of cells, types of batteries, factors affecting battery capacity, voltage and current level, types of discharge, applications of lithium ion batteries in electronic devices, and electric vehicle, basics of solar energy, brief history of solar energy utilization, various approaches of utilizing solar energy, formation of solar cell and its equation, fill factor and maximum power, silicon solar cell, tandem solar cell, dye sensitized solar cell; organic solar cell.		
12. Brief Description of self-learning / E-learning component:		
https://nptel.ac.in/courses/108/108/108108147/ https://nptel.ac.in/courses/108/106/108106135/ https://www.youtube.com/watch?v=G6MIQlIIozg&list=PLLy_2iUCG87BMH9aXArALEv_eH_f63kQu https://onlinecourses.nptel.ac.in/noc19_ee41/preview		
13. Books Recommended		
1. Yariv, Photonics: Optical Electronics in Modern Communications, Oxford University Press, ISBN: 978-0195687057. 2. Patranabis D, Sensors and Transducers, Prentice Hall India Learning Private Limited, ISBN: 978-8120321984 3. Fraden Jacob , Handbook of Modern Sensors: Physics, Designs, and Applications, Springer Nature (SIE), ISBN: 978-8132230984 4. Jacob Fraden, Handbook of Modern Sensors Hardcover, Springer Nature, ISBN: 978-3319193021		

1. Name of the Department: Physics						
2. Course Name	**Advanced Applied Physics Lab**	**L**	**T**		**P**	
3. Course Code	17080409	0	0		2	
4. Type of Course (use tick mark)		**Core ()**	**DSE (√)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 0		**Tutorials = 0**		**Practical = 26**		

8. Course Description:

Experiments include the characteristics of transducer devices, applications of laser and solar cell.

9. Course Objectives:

To understand the characteristics curves for transducer devices, sensors, solar cell and applications of laser.

10. Course Outcomes (COs):

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

1. Understand the characteristic curve of transducer devices.
2. Understand the operation and applications of laser.
3. Understand the operation of solar cell.

11. List of Experiments

1. To verify the characteristics of strain gauge.
2. To verify the characteristics of RTD (Resistance Temperature Detector) using wheat stone bridge.
3. To study the characteristics of piezoelectric transducer.
4. To plot the area characteristics and spectral characteristics of a solar cell.
5. To measure the peak power and beam divergence of a given laser beam.
6. Using He-Ne laser to measure width of a narrow slit.
7. Using He-Ne laser to measure diameter of a thin wire.
8. To study the characteristics of a semiconductor laser.
9. To study the characteristics of a solar cell (illumination Characteristics, Current Voltage Characteristics, Power Load Characteristics).
10. To count the number of slits in a diffraction grating using He-Ne laser.

Note: The list of the experiment given above should be considered as suggestive of the standard and available equipment. The faculty members are authorised to add or delete from this list whenever considered necessary.

12. Book Recommended

1. B.K. Jones, Electronics for Experimentation and Research. Prentice-Hall, ISBN-13 : 978-0132507547
2. R. A. Dunlup, Experimental Physics: Modern Methods, New Delhi: Oxford University Press, ISBN-13 : 978-0195049497
3. K M Varier , A Joseph , Advanced Experimental Techniques in Modern Physics, Anu Books, ISBN: 978-93-86306-29-6

1. Name of the Department: Physics						
2. Course Name	**Spectroscopic Techniques**	**L**	**T**		**P**	
3. Course Code	17080410	4	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE(√)**		**SEC()**	
5. Prerequisite (if any)		**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 52		**Tutorials = 0**		**Practical = 0**		
8. Course Description:						

This course includes basics of spectroscopy, UV/Visible spectroscopy, Mossbauer and X-ray Photoelectron Spectroscopy, nonlinear phenomenon and applications of Laser spectroscopy.

9. Course Objectives:

To understand the basics of different type spectroscopy and topics of current research interest such XPS like ESCA, EDAX etc., chemical shift, stoichiometric analyses and electronic structure.

10. Course Outcomes (COs):

1. Demonstrate the comprehensive theoretical and experimental set up of basic spectroscopic techniques that use different spectroscopy
2. Different Spectroscopy in solving complex problems, and conceptualizing their solutions from Mossbauer and X-ray Photoelectron Spectroscopy
3. Experimental set up theoretical based skill in the spectroscopic and laser applications
4. Techniques and instrumentation for laser and spectroscopy with concepts and phenomena that are characteristic of lasers

11. Unit wise detailed content

Unit-1	**Number of lectures = 13**	**Title of the unit: Basics of Spectroscopy and UV/Visible spectroscopy**

Basics of Spectroscopy, Energy of electromagnetic radiation, Quantization of energy, Mechanisms of interaction of electromagnetic radiation with matter, Absorption peaks and line widths. UV/Visible Absorption Spectroscopy, Beer Lambert law, Deviations from Beer Lambert's law.

Unit – 2	**Number of lectures = 13**	**Title of the unit: Mossbauer and X-ray Photoelectron Spectroscopy**

Mossbauer Spectroscopy: the Mossbauer effect, experimental methods, hyperfine interactions, molecular and electronic structures, **X-ray Photoelectron spectroscopy:** Experimental technique, XPS spectra and its interpretations, other derivative forms of XPS like ESCA, EDAX etc., chemical shift, stoichiometric analyses, electronic structure.

Unit – 3	**Number of lectures = 13**	**Title of the unit: Non-Linear Phenomenon and related spectroscopy**

Non-linear phenomena and generation of short pulses, laser system for spectroscopy, instrumentation for detection of optical signals and time-resolved measurements, absorption spectroscopy, fluorescence spectroscopy, Raman spectroscopy, non-linear spectroscopy, ultra-fast laser spectroscopy.		
Unit – 4	**Number of lectures = 13**	**Title of the unit: Applications of Laser Spectroscopy**
Cooling and Trapping of Atoms, Principles of Doppler Cooling, Polarization Gradient Cooling Qualitative Description of Ion Traps, Optical Traps and Magneto-Optical Traps, Bose Condensation, Applications of Laser.		

12. Brief Description of self- learning / E-learning component:

For basic conceptual understanding and detail study, students may get the study material from the following links.

1. https://nptel.ac.in/courses/102103044/pdf/mod2.pdf
2. https://www.photonics.com/.../**Lasers**_Understanding_the_**Basics**
3. https://en.wikipedia.org/wiki/List_of_**laser_applications**
4. www.bgu.ac.il/~glevi/website/Guides/**Lasers**.pdf
5. **ieee**explore.**ieee**.org/document/8048469/

13. Books Recommended

1. B.B Laud: Laser and nonlinear optics, ISBN No. 8122403247, 9788122403244, Publisher Wiley 1991
2. Harold J. Metcalf Peter van der Straten, Laser Cooling and Trapping, ISBN No. 978-0-387-98728-6 Springer, 1999.
3. Demtroder and Wolfgang: Laser Spectroscopy: Basic Concepts and Instrumentation and Instrumentation, ISBN No. 978-3-662-05155-9, 2003, Springer-Verlag Berlin Heidelberg
4. Svelto, Orazio : Principles of Lasers, Edition:4, ISBN No. 978-1-4757-6266-2, 1998, Publishers Springer US
5. J. M. Hollas. High Resolution Spectroscopy, 2nd Edit. ISBN: 978-0-471-97421-5, 1998, Wiley Publication
6. Anne Thorne, Spectrophysics, ISBN No. 978-94-009-1193-2, Edition. 1, 1988, Springer Netherlands.

1. Name of the Department: Physics						
2. Course Name	**Spectroscopic Techniques-Lab**	**L**	**T**		**P**	
3. Course Code	17080411	0	0		2	
4. Type of Course (use tick mark)		**Core ()**	**DSE (√)**		**SEC ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 0		**Tutorials = 0**	**Practical = 26**			

8. Course Description:

This course includes basics of spectroscopy, UV/Visible spectroscopy, Mossbauer and X-ray Photoelectron Spectroscopy, nonlinear phenomenon and applications of Laser spectroscopy

9. Course Objectives:

1. Demonstrate the experimental knowledge of basic spectroscopic techniques that use different spectroscopy and lasers

2. Experimental knowledge of spectroscopy in solving complex problems, and conceptualizing their solutions from Mossbauer and X-ray Photoelectron Spectroscopy

3. Laboratory exercises that illustrate the Provide a degree of experimental skill in the spectroscopic and laser applications

4. Research based knowledge on the techniques and instrumentation for laser and spectroscopy with concepts and phenomena that are characteristic of lasers

10. Course Outcomes (COs):

After successful completion of the course, students will be able to correlate the theoretical concepts of different type of spectroscopy and identify its practical applications through experiment procedure and results

11. List of Experiments

1. To determine the variation of refractive index of the material of prism with wavelength and to verify Cauchy's dispersion formula.
2. To determine the wavelength of laser using Michelson Interferometer.
3. Measurement of Raman spectrum of CCl4 by Raman Spectroscopy
4. Measurement and analyses of fluorescence spectra of liquids/solids (I_2) by fluoresce spectra photometer
5. Study of Photo luminance spectra of alkali metal by PL Spectroscopy
6. Measurement and analysis of Sodium by Photoelectron spectroscopy (XPS)
7. Measurement and analysis of ceramics and inorganic oxides by UV/Visible Absorption Spectroscopy
8. Measurement and analysis of emission spectrum Organic and Inorganic compound by Photo luminance spectroscopy
9. Determination of optical band gap using UV visible spectroscopy of Inorganic compounds
10. Study of balanced state of different atoms present in a Organic/Inorganic compound by XPS Spectroscopy
11. Study of lifetime of photo luminance emission spectrum using time resolve spectroscopy
12. Measurement of Band positions and determination of vibrational constants of AlO molecule
13. Measurement of Band positions and determination of vibrational constants of N_2 molecule
14. Measurement of Band positions and determination of vibrational constants of CN molecule

Note: The list of the experiment given above should be considered as suggestive of the standard and available

equipment. The faculty members are authorised to add or delete from this list whenever considered necessary.
12. Book Recommended:
1. W. Demtroder: Laser Spectroscopy: Basic Concepts and Instrumentation and Instrumentation, ISBN No. 978-3-662-05155-9, 2003, Springer-Verlag Berlin Heidelberg. 2. J. M. Hollas. High Resolution Spectroscopy, 2nd Edit. ISBN: 978-0-471-97421-5, 1998, Wiley Publication 3. Anne Thorne, Spectrophysics, ISBN No. 978-94-009-1193-2, Edition. 1, 1988, Springer Netherlands. 4. J. M. Hollas. Modern Spectroscopy, ISBN No. 978-0471911210, 1986, Wiley–Blackwell.