CMS COLLEGE KOTTAYAM
(AUTONOMOUS)

Affiliated to the Mahatma Gandhi University
Kottayam, Kerala

CURRICULUM FOR POST GRADUATE PROGRAMME

MASTER OF SCIENCE IN PHYSICS

UNDER CREDIT AND SEMESTER SYSTEM (CSS)
(With effect from 2019 Admissions)

Approved by the Board of Studies on 14th June 2019

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ACKNOWLEDGEMENT

The Board of Studies of Department of Physics, CMS College, Kottayam places on record their gratitude to all the eminent academicians who contributed to the framing of post graduate syllabus 2019.The guidance and recommendations from the domain experts in designing different courses played a crucial role in shaping this curriculum to this present level. Ialso like to convey my gratitude to all the members of the Board of Studies whose pragmatic and collaborative approach made this venture a grand success.

Dr. Reenu Jacob
Chairman
Board of Studies

Kottayam
14.06.2019

PREFACE

The curriculum of an institution of higher learning evolves with time, reflecting the ever-changing needs of the society and the students. The dynamic feature of the curriculum makes the learning process a truly sublime experience for all.

Department of Physics has taken meticulous efforts to ensure a well-balanced curriculum. The Physics community of our College provides better understanding of the fundamental laws of nature, promoting the highest ethical principles in scientific research, critical thinking and openness to social and technological changes.

The M.Sc.programme is designed to develop professional skills for students to take up significant role in industrial or academic life, while giving the experience of independent work and team spirit. Further the curriculum enables students to develop insights into the specialized research areas such as non-linear dynamics, materials science, nano-science, and photonics along with the creative laboratory environment with a range of experiments from classic to advanced physics.

The syllabus intends to provide the students many opportunities to engage with the evolving world of learning. Focused efforts in developing programme and course outcomes provide cognitive and intellectual skills of the learners and provide confidence to carry out independent and scholarly research in area of professional interest and to position themselves in the global arena.

The syllabus is part of our resolve to create a stimulating academic culture in the institution to access knowledge and participate in its expansion and progression.

REGULATIONS FOR POST GRADUATE PROGRAMMES UNDER CREDIT SEMESTER SYSTEM 2019

Preamble

CMS College Kottayam (Autonomous) was conferred with the Autonomous status as per UGC No.F.22-1/2016(AC) Dtd. 9th March 2016 and Mahatma Gandhi U.O.No.2732/VII/2016/Acad. Dtd.12th May 2016.

REGULATIONS

CMS College Kottayam (Autonomous) follows Credit Semester System (CSS) for the Post Graduate programmes from the Academic year 2019-20. The Post Graduate programmes of the college are being redesigned and revised in tune with the modifications effected at the UGC Curriculum Framework. This will be reflected in the scheme, course content and mode of examination and Evaluation system. The scheme and syllabus of all the programmes are being revised accordingly. The revisions were effected based on the recommendations made at the Curriculum Revision workshops conducted for the purpose besides several sittings of the Curriculum Revision Committee.

1. TITLE

1.1. These regulations shall be called **"CMS COLLEGE KOTTAYAM (AUTONOMOUS) REGULATIONS FOR POST GRADUATE PROGRAMMES UNDER CREDIT AND SEMESTER SYSTEM 2019"**

2. SCOPE

2.1 Applicable to all regular Postgraduate Programmes conducted by the CMS College Kottayam (Autonomous) with effect from 2019 admissions.

2.2 Medium of instruction is English unless otherwise stated therein.

3. DEFINITIONS

3.1. **Academic Week** is a unit of five working days in which the distribution of work is organized from day one to day five, with five contact hours of one hour duration on each day.

3.2. **Semester** means a term consisting of **90** working days, within **18** five-day academic weeks for teaching, learning and evaluation.

3.3. **Programme** means a two year programme of study and examinations, spread over four semesters, with a set of courses, the successful completion of which would lead to the award of a degree.

3.4. **Course** comprises a set of classes or a plan of study on a particular subject which will be taught and evaluated within a semester of a study programme.

3.5. **Core course** means a course which should compulsorily be studied by a student as requirement in the subject of specialization within a degree programme.

3.6. **Elective Course** means an elective course chosen from the discipline/ subject, in an advanced area.

3.7. **Credit** is the numerical value assigned to a course according to the duration of the classes or volume of the syllabus of the course**.**

3.8. **Department** means any teaching department in the college.

3.9. **Dean of Academic Affairs** is a teacher nominated by the Academic Council to coordinate the academic affairs of the college relating to academic planning, curriculum implementation and review.

3.10. **Dean of Student Affairs** is a teacher nominated by the Academic Council to coordinate the admissions, grievances and other student related services.

3.11. **Department Council** means the body of all teachers of a department in the college.

3.12. **Department Coordinator** is a teacher nominated by a Department Council to co-ordinate the In-Semester examination of the PG programme in that department.

3.13. **Faculty Advisor** means a teacher from the parent department nominated by the Department Council, who will advise the students of a class on academic matters.

3.14. **Course Teacher** means a teacher who is in charge of a course. If a course is taught by more than one teacher, one teacher should be assigned as course teacher, nominated by the HOD. The course teacher shall be responsible for the valuation of answer scripts of examinations and other continuous assessments.

3.15. **In-Semester Assessment (ISA)** means assessment consisting of Attendance, Assignment/Seminar/Viva voce and Examination (theory and practical).

3.16. **End Semester Assessment (ESA)** means Examination conducted at the end of each semester for all courses (theory and practical).

3.17. **Internal Examiner** means a teacher working in the college.

3.18. **External Examiner** means a teacher from outside the college.

3.19. **Grace Marks** shall be awarded to candidates as per the orders issued by Mahatma Gandhi University.

3.20. **Grade** means a letter symbol (A, B, C, etc.), which indicates the broad level of performance of a student in a Course/ Semester/Programme.

3.21. **Grade Point** (GP) is the numerical indicator of the percentage of marks awarded to a student in a course.

3.22. College Average (CA) means average mark secured (ISA+ESA) for a course at the college level.

3.23. Words and expressions used and not defined in this regulation shall have the same meaning assigned to them in the Act and Statutes of the University, UGC Regulations and the Constitution of the CMS College Kottayam (Autonomous).

4. ELIGIBILITY FOR ADMISSION AND RESERVATION OF SEATS

Eligibility for admission, norms for admission and reservation of seats for various Postgraduate Programmes shall be according to the regulations framed/orders issued by Govt. of Kerala, Mahatma Gandhi University and CMS College Kottayam in this regard.

5. PROGRAMME STRUCTURE

5.1 The nomenclature of all PG programmes shall be as per the specifications of University Grants Commission and the Mahatma Gandhi University.

5.2 Credit Semester System (CSS) will be followed for all PG Programmes from the academic year 2019– 2020.

5.3 All the PG Programmes will be of two-year duration with four Semesters. A student may be permitted to complete the Programme, on valid reasons, within a period of 8 continuous semesters from the date of commencement of the first semester of the programme.

5.4 There will be three/four/five courses in each semester and one viva voce and dissertation at the end of the fourth semester.

5.5 There will be three components for the programme viz. core course, elective course and project spread over four semesters.

5.6 The total credits required for completing a PG Programmeis **80**.

5.7 The Syllabus for all courses in each semester has been divided into five modules based on certain thematic commonalities.

6. EVALUATION SYSTEM

i. The evaluation scheme for each course shall contain two parts:
(a) In-Semester Assessment (ISA)
(b) End-Semester Assessment (ESA)

ii. The proportion of ISA to ESA will be 1:3.

iii. The marks secured for each course shall be converted as grades. The grades for different semesters and overall programme are assigned based on the corresponding semester grade point average and cumulative grade point average respectively.

iv. A separate minimum of 40% is mandatory for both ISA and ESA to pass for every course.

6.1 EVALUATION OF THEORY COURSES

The marks allotted for theory courses in End-Semester Assessment shall be 120 and that for the In-Semester Assessment will be 40.

A. IN-SEMESTER ASSESSMENT

The In-semester assessment for theory is based on the marks obtained for Attendance, Assignment, Major Seminar and two Test Papers for a particular course.

(i) Attendance

Percentage of attendance	**Mark**
90 and above	6
85 - 89	5
80 - 84	4
76 - 79	3
75	2
Below 75	0

Maximum marks = 6

(ii) Assignment (One assignment per course)

Evaluation Component	**Mark**
Review of related literature	2
Content	3
Reference	2
Punctuality	1

Maximum marks = 8

(iii) Major Seminar

A student should present one Major Seminar in a Semester. The faculty advisor should allot students to the respective course teacher in a semester. The seminar topics shall be incorporated in the syllabus for each course/ declared in the beginning of each semester. The student shall prepare the seminar paper with the guidance of the course teacher. The student is expected to make a detailed presentation in a common session in the department, with students and all course teachers. The student shall also make a brief conclusion including the future scope of studying the topic. The teacher in charge of the particular course has to act as the moderator for the seminar.

The course teachers of that semester shall evaluate the seminar and give marks for their course or the average mark of all the evaluators shall be taken as the seminar mark for each course of a semester.

Evaluation Component	Mark
Involvement/punctuality	1
Review of related literature	1
Content	3
Presentation	3
Interactions/ justification	1
Conclusion	1

Maximum marks = 10

(iv) Test paper

For each course, two In-Semester examinations of total 16 marks shall be conducted. One of the test paper will be centralized examination of 8 marks and the remaining 8 marks will be awarded with one or more class tests conducted by the course teacher.

B. END -SEMESTER ASSESSMENT

End-Semester examinations for each course are conducted at the end of every semester with a maximum marks of 120. The examination for each course will have two components viz., descriptive test and an objective type test. Questions shall be set to evaluate the attainment of course outcomes. The question paper for each course will be generated from the Question Bank which is prepared by due mapping of Course outcomes and Program Specific Outcomes.

(i) Descriptive Test

A written examination with a maximum marks of 100 and of three hours duration will be conducted.

PATTERN OF QUESTIONS

A question paper shall be a judicious mix of short answer type, short essay/problem solving type and long essay type questions.

No.	Section	Type of questions	Total Questions	Number of questions to be answered	Mark for each question	Total Marks
1	Section A	Short answer type	8	5	4	20

2	Section B (One pair should be from each module)	Short essay/problem solving type	10 (Either/or)	5	8	40
3	Section C	Long essay type	4	2	20	40
	Total		**22**	**12**	-	**100**

(ii) Objective Test

A Multiple Choice Objective type Test shall be a component of the End-semester examination which will be conducted in the online mode for each course. The marks obtained shall be converted into 20. The objective type examination for all courses in a semester shall be conducted in a session of one hour. The number of questions in Arts stream will be 50 and that of Science and Mathematics stream will be 40.Questions should be equally distributed among the courses in a semester. There will be four choices for each question. Each question carries 4 marks for correct answer, zero marks for no answer and -1 marks for wrong answer.

6.2 EVALUATION OF PRACTICAL COURSES

Practical examination will be conducted at the end of each semester/ end of an academic year. The time of conduct of the practical examination will be decided by the respective BOS.

A. **IN-SEMESTER ASSESSMENT**

Evaluation Component	Mark
Attendance	6
Lab Involvement	8
Test	12
Record	8
Viva	6

Maximum Marks = 40

The components and the marks can be modified by the concerned BOS/Expert committee within the limit of maximum marks.

B. **END- SEMESTER ASSESSMENT**

Evaluation Component	Mark
Attendance	18
Lab Involvement	24
Test	36
Record	24
Viva	18

Maximum Marks = 120

The components and the marks can be modified by the concerned BOS/Expert committee within the limit of maximum marks.

6.3 EVALUATION OF PROJECT

An academic project work shall be done and a dissertation shall be submitted in the final semester of the programme. There will be both In semester and End semester assessment for the project work.

A. IN- SEMESTER ASSESSMENT

Evaluation Component	Mark
Relevance of the topic	5
Project content and report	15
Presentation	15
Project viva	10
Paper presentation* in Seminar/Conference or publications with ISBN/ISSN (*valid certificate to be submitted)	5

Maximum marks = 50

The components and the marks can be modified by the concerned BOS/Expert committee within the limit of maximum marks.

B. END -SEMESTER ASSESSMENT

The dissertation at the end of final Semester will be evaluated by a panel of one internal evaluator assigned by HOD and one external evaluator / a panel of two external evaluators, as may be decided by the respective BOS.

Evaluation Component	Mark
Relevance of the topic	15
Project content and report	45
Presentation	45
Project viva	30
Paper presentation* in Seminar/Conference or publications with ISBN/ISSN (*valid certificate to be submitted)	15

Maximum marks = 150

The components and the marks can be modified by the concerned BOS/Expert committee within the limit of maximum marks.

6.4 EVALUATION OF COMPREHENSIVE VIVA VOCE

A comprehensive viva voce shall be done at the end of the final semester. There will be both In-semester and End-semester assessment for the viva voce examination.

A. IN - SEMESTER ASSESSMENT

Evaluation Component	Mark
+2/ UG level questions	4
PG syllabus level questions	10
Subject of interest based questions	8
Advanced level questions	3

Maximum marks = 25

The components and the marks can be modified by the concerned BOS/Expert committee within the limit of maximum marks.

B. END- SEMESTER ASSESSMENT

The comprehensive Viva Voce Examination at the end of final Semester will be evaluated by a panel of one internal evaluator assigned by HOD and one external evaluator / a panel of two external evaluators, as may be decided by the respective BOS.

Evaluation Component	Mark
+2/ UG level questions	12
PG syllabus level questions	30
Subject of interest based questions	24
Advanced level questions	9

Maximum marks = 75

The components and the marks can be modified by the concerned BOS/Expert committee within the limit of maximum marks.

7. Grievance Redressal Mechanism

In order to address the grievance of students regarding In-Semester assessment, a two-level Grievance Redressal mechanism is established.

Level 1: Department Level: The Department cell is chaired by the HOD, Department Coordinator as member secretary and Course teacher in-charge as member. If the grievance is not redressed at the Department level, the student shall report the grievance to the College Level Grievance Redressal Cell.

Level 2: **College level**: College Level Grievance Redressal Cell has the Vice-Principal as the Chairman, Dean of Student Affairs as the Member Secretary and HOD of concerned Department as member.

8. Eligibility for End Semester Examination

A minimum of 75% average attendance for all the courses is mandatory to register for the examination. Condonation of shortage of attendance to a maximum of 10 days in a semester subject to a maximum of 2 times during the whole period of the programme may be granted by the College on valid grounds. Attendance may be granted to students attending University/College union/Co-curricular activities for the days of absence, on production of participation/attendance certificates, within one week, from the teacher in charge of the activity and endorsed by the Dean of Student Affairs. This is limited to a maximum of 10 days per semester. Monthly Attendance report will be published in the college website on or before the 10th of every month. Those students who are not eligible even with condonation of shortage of attendance shall repeat the semester along with the next batch after obtaining readmission.

9. Promotion to the next Semester

Those students who possess the required minimum attendance and have registered for the End Semester Examination during an academic semester are promoted to the next semester.

Those students who possess the required minimum attendance and progress during an academic semester and could not register for the semester examination are permitted to apply for Notional Registration to the examinations concerned enabling them to get promoted to the next semester.

10. Eligibility for Readmissions

An additional chance of readmission will be given to those students who could not register for the examination due to shortage of attendance. Readmitted students shall continue their studies with the subsequent batch of students. If an applicant for readmission is found to have indulged in ragging or any other misconduct in the past, readmissions shall be denied.

11. MARK CUM GRADE CARD

The College under its seal shall issue to the student a MARK CUM GRADE CARD on completion of each semester/programme, which shall contain the following information:

(a) Name of the College
(b) Title of the Postgraduate Programme
(c) Name of the Semester
(d) Name and Register Number of the student
(e) Date of publication of result
(f) Code, Title, Credits and Maximum Marks (ISA, ESA & Total) of each course opted in the semester.
(g) ISA, ESA and Total Marks awarded, Grade, Grade point and Credit point in each course opted in the semester
(h) College average (CA) of the marks of all courses
(i) The total credits, total marks (Maximum & Awarded) and total credit points in the semester

(j) Semester Grade Point Average (SGPA) and corresponding Grade.
(k) Cumulative Grade Point Average (CGPA) and corresponding Grade.

The final Mark cum Grade Card issued at the end of the final semester shall contain the details of all courses taken during the study programme and the overall mark/grade for the total programme.

There shall be a College Level Monitoring Committee comprising Principal, Vice Principal as member-secretary, Dean of Academic Affairs, Controller of Examinations, IQAC Director and Administrative Assistant as members for the successful conduct of the scheme.

12. CREDIT POINT AND CREDIT POINT AVERAGE

Credit Point (CP) of a course is calculated using the formula:-
CP = C × GP, where C is the Credit and GP is the Grade point

Semester Grade Point Average (SGPA) of a Semester is calculated using the formula:-
SGPA = TCP/TC, where TCP is the Total Credit Point of that semester,ie, $\sum_1^n \mathrm{CPi}$; *TC is the Total Credit of that semesterie,* $\sum_1^n \mathrm{Ci}$, *where n is the number of courses in that semester*

Cumulative Grade Point Average (CGPA) is calculated using the formula:-
CGPA = TCP/TC, where TCP is the Total Credit Point of that programmeie, $\sum_1^n \mathrm{CPi}$; *TC is the Total Credit of that programme, ie,* $\sum_1^n \mathrm{Ci}$ *, where n is the number of courses in that programme*

Grades for the different courses, semesters and overall programme are given based on the corresponding CPA as shown below:

CPA	Grade with Indicator
4.5 to 5.0	A+ Outstanding
4.0 to 4.49	A Excellent
3.5 to 3.99	B+ Very Good
3.0 to 3.49	B Good (Average)
2.5 to 2.99	C+ Fair
2.0 to 2.49	C Marginal
Up to 1.99	D Deficient (Fail)

13. TRANSITORY PROVISION

Notwithstanding anything contained in these regulations, the Principal shall, for a period of six months from the date of coming into force of these regulations, have the power to provide by order that these regulations shall be applied to any programme with such modifications as may be necessary.

The Principal is also authorized to issue orders for the perfect realization of the regulations.

Annexure I

(Model Mark Cum Grade Card)

CMS COLLEGE KOTTAYAM (AUTONOMOUS)

Affiliated to Mahatma Gandhi UniversityKottayam

(Autonomous College as per UGC order no.F.22-1/216(AC)dated 9th March 2016)

MARK CUM GRADE CARD

Section	:	
Name of the Candidate	:	
Unique Permanent Registration Number	:	
Degree	:	
Programme	:	
Stream	:	
Name of the Examination	:	
Date of Publication of Result	:	

Course Code	Course Title	Credits (c)	Marks						Grade Awarded (G)	Grade Point (GP)	Credit Point (C x	College Average	Result
			ISA		ESA		TOTAL						
			Awarded	Maximum	Awarded	Maximum	Awarded	Maximum					

ISA - In - Semester Assessment, ESA – End - Semester Assessment

SGPA: **SG:**

Checked by **Section Officer** **Controller of Examinations**

Date:

Annexure II

CMS COLLEGE KOTTAYAM (AUTONOMOUS)

Kerala, India – 686 001Website: www.mscollege.ac.in
e-mail:kottayamcmscollege@gmail.comTel: 91-481-2566002, Fax: 91-481-2565002
Affiliated to Mahatma Gandhi University Kottayam, Kerala
(Autonomous College as per UGC Order No.F.22-1/216 (AC) dated 9th March 2016)

CONSOLIDATED MARK CUM GRADE CARD

Name of the Candidate:

Unique Permanent Register Number (UPRN):

Degree:

Programme:

Stream:

Date of Birth:

Date of Eligibility for the Degree:

PHOTO

CMS COLLEGE KOTTAYAM (AUTONOMOUS)

Name: UPRN:

Course Code	Course Title	Credits (C)	Marks						Grade Awarded (G)	Grade Point (GP)	Credit Point (CxGP)	College Average (CA)	Result
			ESA		ISA		Total						
			Awarded	Maximum	Awarded	Maximum	Awarded	Maximum					

Final Result

Cumulative Grade Point Average CGPA :

Semester Summary

Sl.No	Semester	Credit	SGPA	Grade	Month/year	Result
	Semester 1 Semester 2 Semester 3 Semester 4					

Date: **Controller of Examinations**

Annexure III

(Reverse side of the Mark cum Grade Card (COMMON TO ALL SEMESTERS))

Description of the Evaluation Process

Grade and Grade Point

The Evaluation of each Course comprises of Internal and External Components in the ratio 1:3 for all Courses.

Grades and Grade Points are given based on the percentage of Total Marks (Internal + External) as given in Table 1

(Decimals are to be rounded mathematically to the nearest whole number)

Table 1

% Marks	Grade	GP
Equal to 88 and above	A+ Outstanding	5
Equal to 76 and < 88	A Excellent	4
Equal to64 and < 76	B+ Very Good	3
Equal to 52 and < 64	B Good(Average)	2
Equal to 40 and below 52	C Marginal	1
Below 40	D Deficient (Fail)	0
	Ab Absent	

Credit point and Credit point average

Grades for the different Semesters and overall Programme are given on a 7-point Scale based on the corresponding CPA, as shown in Table 2.

Table 2

CPA	Grade with Indicator
4.5 to 5.0	A+ Outstanding
4.0 to 4.49	A Excellent
3.5 to 3.99	B+ Very Good
3.0 to 3.49	B Good (Average)
2.5 to 2.99	C+ Fair
2.0 to 2.49	C Marginal
Up to 1.99	D Deficient (Fail)

Credit point (**CP**) of a paper is calculated using the formula $CP = C \times GP$,**where C is the Credit; GP is the Grade Point**

Semester or Programme (cumulative) Grade Point Average of a Course/Programme is calculated using the formula

SGPA/CGPA = $\frac{TCP}{TC}$**, where TCP is the Total Credit Point; TC is the Total Credit**

<u>NOTE</u>

A separate minimum of 40% marks each for internal and external (for both theory and practical) are required for a pass for a course. For a pass in a programme, a separate minimum of **Grade C** is required for all the individual courses. If a candidate secures **D Grade** for any one of the course offered in a Semester/Programme**only D grade** will be awarded for that Semester/Programme until he/she improves this to **C GRADE** or above within the permitted period.

<u>**CURRICULUM**</u>

GRADUATE PROGRAMME OUTCOMES (GPO) – POST GRADUATE PROGRAMMES

At the completion of the Post Graduate Programme, the student will be able to accomplish the following programme outcomes.

GPO No.	Graduate Programme Outcomes
GPO.1	**Critical Thinking**: Ability to engage in independent and reflective thinking in order to understand logic connections between ideas.
GPO.2	**Effective Communication:** Development of communication skills for effectively transmitting and receiving information that focuses on acquiring knowledge, problem solving, improving on arguments and theories thereby paving the way for better employability and entrepreneurship.
GPO.3	**Social Consciousness:** Acquire awareness towards gender, environment, sustainability, human values and professional ethics and understand the difference between acting, responding and reacting to various social issues.
GPO.4	**Multidisciplinary Approach:** Combining various academic disciplines and professional specializations to cross borders and redefine problems in order to explore solutions based on the new understanding of complex situations.
GPO.5	**Subject Knowledge:** Acquiring knowledge at a higher level that would help develop the necessary skills, fuel the desire to learn and contribute to the field of expertise thereby providingvaluable insights into learning and professional networking with the aim of cateringto the local, national and global developmental needs.
GPO.6	**Lifelong Learning**: Understanding the necessity of being a lifelong learner for personal enrichment, professional advancement and effective participation in social and political life in a rapidly changing world.

PROGRAMME SPECIFIC OUTCOMES

	Programme Specific Outcomes Upon completion of M.Sc Physics Programmes, the graduates will be able to:	**GPO NO:**
PSO-1	Acquire high-level knowledge in classical mechanics, quantum mechanics, electrodynamics and statistical mechanics and apply it to complex problems in physics and other areas	1,5
PSO-2	Develop proficiency in the analysis of complex physical problems and the use of mathematical or other suitable techniques to solve them	1,2,5
PSO-3	Apply theoretical knowledge and critical reasoning skills to model and solve practical problems	1,2,5
PSO-4	Understand and apply inter-disciplinary concepts and computational skills for understanding and describing the natural phenomenon	4,5,6
PSO-5	Explore the multidisciplinary areas through the selection of advanced electives	1.4
PSO-6	Develop skills for a research career in academia or industry by learning advanced ideas and techniques with emphasizing the underlying concepts of Physics	3,5,6

PROGRAMME DESIGN

1.1 Theory Courses:

There are sixteen theory courses distributed in the four semesters in the M.Sc. Physics Programme. Among the sixteen courses, twelve courses are common to all the students. Semester I and semester II include four core papers while semester III and semester IV have two core papers. There are two elective bunches given in this syllabus out of which Department chooses one elective bunch in one academic year. Two elective papers will come in the semester III and the other two in semester IV.

1.2 Practical:

All semesters have practical courses. Semester I, II& III have common practical courses while semester IV practical will subject to the elective bunch selected. A minimum of twelve experiments should be done and recorded for each semester.

Besides theory and practical courses, project and viva voce examination will also be there at the end of semester IV.

The course design is given below:

Sl.No	**Course Type**	**No. of Courses**	**Total Credits**
1.	Core Courses	12	46
2.	Core Practical	3	12
3.	Elective Courses	4	14
4.	Elective Practical	1	4
5.	Viva voce	1	2
6.	Dissertation	1	2
	Total	**22**	**80**

PROGRAMME STRUCTURE

	Code	Course Name	Credit	Hrs/W	Total Credits
Semester 1	PH1921101	Classical Mechanics	4	3	19
	PH1921102	Electrodynamics	4	4	
	PH1921103	Electronics	4	4	
	PH1921104	Mathematical Methods in Physics- I	3	3	
	PH1921601	General Physics Practical	4	10	
Semester 2	PH1922105	Mathematical Methods in Physics- II	4	4	19
	PH1922106	Thermodynamics and Statistical Mechanics	4	4	
	PH1922107	Condensed Matter Physics	4	4	
	PH1922108	Quantum Mechanics - I	3	3	
	PH1922602	Electronics Practical	4	10	
Semester 3	PH1923109	Quantum Mechanics – II	4	4	19
	PH1923110	Computational Physics	4	4	
	PH1923301	Elective Course I	4	4	
	PH1923302	Elective Course II	3	3	
	PH1923603	Computational Physics Practical	4	10	
Semester 4	PH1924111	Atomic and Molecular Physics	4	4	23
	PH1924112	Nuclear Physics and Particle Physics	4	4	
	PH1924305	Elective Course III	4	4	
	PH1924306	Elective Course IV	3	3	
	PH1924701	Elective Practical	4	10	
	PH1924801	Project/Dissertation	2	-	
	PH1924901	Viva Voce	2	-	
	Total				**80**

(b) Elective Courses:

1. Bunch A: Materials Science

Code	Course Name	Credit	Hrs/W	Semester
PH1923301	Science of Advanced Materials	4	4	3
PH1923302	Solid State Physics for Materials	3	3	3
PH1924305	Nanostructures and Material Characterization	4	4	4
PH1924306	Nano science and Optical spectroscopy	3	3	4
PH1924701	Materials Science Practical	4	10	4

2.BunchB: Electronics

Code	Course Name	Credit	Hrs/W	Semester
PH1923303	Integrated Electronics and Digital Signal Processing	4	4	3
PH1923304	Microelectronics and Semiconductor Devices	3	3	3
PH1924307	Instrumentation and Communication Electronics	4	4	4
PH1924308	Optoelectronics	3	3	4
PH1924702	Advanced Electronics Practical	4	10	4

DETAILED SYLLABUS OF ALL COURSES

SEMESTER I

Course	Details				
Code	PH1921101				
Title	**CLASSICAL MECHANICS**				
Degree	M.Sc.				
Branch(s)	Physics				
Year/Semester	1/ I				
Type	Core				
Credits	4	**Hours/week**	4	**Total hours**	72

CO No.	**Expected Course Outcomes** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Remember the methods involved to study motion of a system.	U	1,6
2	Apply thisconcepts to formulate basic principle	Ap	2,3,4
3	Understand the conservation theorems from symmetry arguments	U	1,6
4	Explain the need of canonical transformation to solve some simple problems.	An	1,6
5	Understand Poisson and Lagrange brackets with their properties	U	1,6
6	Apply Hamilton-Jacobi equation in harmonic oscillator problem	Ap	2,3
7	Analyze central force problem to solve Kepler's law.	Ap	3,4
8	Study the mechanics of rigid body	U	2,3
9	Understand Einstein's field equations from the nature of space and time and approximate it to classical limits with the Poisson approximation	Ap	2,3
10	Solve Lagrange's equations of motion for small oscillations	Ap	2,3
11	Illustrate the concept of chaos with few example and basic definitions	Ap	3,4,5

PSO-Program specific outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO.No.
1.0	**Lagrange's and Hamiltonian Mechanics**		
1.1	Review of Newtonian and Lagrangian formalisms	2	1
1.2	Cyclic co-ordinates	1	1
1.4	Conservation theorems and symmetry properties	2	3
1.5	Hamilton's equations of motion	2	2
1.6	Least action principle - physical significance	2	2
1.7	Calculus of variations	1	2
1.8	Hamilton's principle	2	2
1.9	Examples of calculus of variations	2	2
1.10	Lagrange's equations from Hamilton's principle.	2	2
2.0	**Canonical Transformations and Hamilton-Jacobi Theory**		
2.1	Equations of canonical transformation	2	4
2.2	Harmonic oscillator	1	4
2.3	Poisson brackets and Lagrange brackets	1	5
2.4	Equations of motion in Poisson bracket form	1	5
2.5	Angular momentum Poisson brackets	1	5
2.6	Poisson brackets -invariance under canonical transformations	1	5
2.7	Hamilton-Jacobi equation for Hamilton's principal function	2	6
2.8	Harmonic oscillator problem	2	6
2.9	Hamilton - Jacobi equation for Hamilton's characteristic function	1	6
2.10	Action angle variables	1	6
2.11	Harmonic oscillator problem using action angle variable	1	6
3.0	**Central Force Problem and Rigid Body Dynamics**		
3.1	Reduction of two body to the equivalent one body problem	2	7
3.2	Equations of motion and first integrals	1	7
3.3	Classification of orbits	1	7
3.4	Differential equation for the orbits	2	7
3.5	Virial theorem	1	7
3.6	Kepler problem.	2	7
3.7	Generalized co-ordinates of a rigid body	1	8
3.8	Euler's angles	2	8
3.9	Infinitesimal rotations as vector	1	8
3.10	Coriolis force	1	8
3.11	Angular momentum and inertia tensor	1	8
3.12	Principal axis and kinetic energy	1	8
4.0	**General Theory of Relativity, Mechanics of small oscillations**		
4.1	Principle of equivalence - principle of general covariance	2	9
4.2	Motion of a mass point in a gravitational field - the	2	9

	Newtonian approximation		
4.3	Time dilation - rates of clocks in a gravitational field - shift in the spectral lines	2	9
4.4	Einstein's field equations and the Poisson approximation.	3	9
4.5	Stable and unstable equilibrium	1	10
4.6	Two-coupled oscillators	1	10
4.7	Lagrange's equations of motion for small oscillations	2	10
4.8	Normal co-ordinates and normal modes	1	10
4.9	Oscillations of linear tri-atomic molecules	2	10
5.0	**Classical Chaos**		
5.1	Linear and non-linear systems	1	11
5.2	Integration of linear equation	1	11
5.3	Quadrature method - the pendulum equation	1	11
5.4	Phase plane analysis of dynamical systems	1	11
5.5	Phase curve of simple harmonic oscillator and damped oscillator	2	11
5.6	Phase portrait of the pendulum	1	11
5.7	Bifurcation, logistic map and attractors	1	11
5.8	Universality of chaos, Lyapunov exponent	1	11
5.9	Fractals - fractal dimension	1	11

Text Books:

1. Classical Mechanics, G. Aruldhas, Prentice Hall 2009,
2. Classical Mechanics, J.C. Upadhyaya, Himalaya,2010
3. Classical Mechanics, H. Goldstein, C.P. Poole & J.L. Safko, Pearson 3rd Ed
4. The Theory of Relativity, R.K. Pathria, Dover Pub. Inc. NY,2003

Reference Books:

1. Classical Mechanics, N.C. Rana and P.S. Joag, Tata McGraw Hill
2. Introduction to Classical Mechanics, R.G. Takwa
3. Lagrangian and Hamiltonian Mechanics, M.G. Calkin, World Scientific Pub. Co Ltd
4. Introduction to General Relativity, R. Adler, M. Bazin, M. Schiffer, TMGH.
5. An introduction to general relativity, S. K. Bose, Wiley Eastern.
6. Relativistic Mechanics, Satya Prakash, PragathiPrakashan Pub.
7. Chaos in Classical and Quantum Mechanics, M.C.Gutzwiller, Springer, 1990.
8. Deterministic Chaos, N. Kumar, University Press,
9. Chaotic Dynamics, G.L.Baker&J.P.Gollub, Cambridge Uni. Press, 1996
10. Mathematical Methods for Physicists, G.B. Arfken& H.J. Weber 4th Edition
11. Classical Mechanics, S.L. Gupta, V. Kumar & H.V. Sharma, PragatiPrakashan, 2007

Course	Details				
Code	PH1921102				
Title	**ELECTRODYNAMICS**				
Degree	M.Sc.				
Branch(s)	Physics				
Year/Semester	1/ I				
Type	Core				
Credits	4	**Hours/week**	4	**Totalhours**	72

CO No.	**Expected Course Outcomes** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Explain Maxwell's equations in matter and Poynting's theorem.	U	1,6
2	Explain laws of reflection, refraction as outcomes of electromagnetic boundary conditions.	An	1,3
3	Understand the idea of electromagnetic wave propagation through waveguides and transmission lines	U	1,3,5
4	Express the laws of electrodynamics under relativistic methods	An	1,2
5	Explain the concept and principle of electromagnetic radiation	Ap	1,4

PSO-Program specific outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CONo.
1.0	**Electromagnetic waves**		
1.1	Maxwell's equation in matter	2	1,2,3,4, 5
1.2	Conservation laws and Poynting's theorem	2	1
1.3	Momentum and Maxwell's stress tensor	2	1
1.4	EM Waves - sinusoidal waves	1	1,2
1.5	Boundary condition- reflection and transmission	1	1,2,5
1.6	Polarization	1	2
1.7	EM Waves in vacuum	1	1,2
1.8	Energy and momentum in EM Waves	1	1,2,5
1.9	EM Waves in matter	1	1,2,5
1.10	Normal and oblique incidence	2	2
1.11	EM Waves in conductors	2	1,2
2.0	**Waveguides and transmission lines**		

2.1	Waves between parallel conducting planes	2	1,3
2.2	Rectangular wav guide	2	1,3
2.3	Transmission lines - Fundamentals, characteristic impedance and losses	3	3
3.0	**Potentials and Fields**		
3.1	Potential formulation	1	1,5
3.2	Gauge transformations	2	1,5
3.3	Retarded Potentials	2	5
3.4	Jefimenko's equations	2	5
3.5	LienardWiechert Potential	3	5
3.6	Moving point charges	2	5
3.7	Field of moving point charge	3	5
4.0	**Electric dipole radiation**		
4.1	Multipole expansion	2	1,5
4.2	Electric field of a dipole	2	5
4.3	Pure and physical dipole	2	5
4.4	Radiation	2	5
4.5	Electric dipole radiation	3	5
4.6	Magnetic dipole radiation	3	5
5.0	**Relativistic Electrodynamics**		
5.1	Special theory of Relativity	1	4
5.2	Geometry of relativity	3	4
5.3	Lorentz transformation	1	4
5.4	Einstein's velocity addition rule	1	4
5.5	Structure of space time	1	4
5.6	Proper time and proper velocity	1	4
5.7	Relativistic energy and momentum	1	4
5.8	Relativistic kinematics	1	4
5.9	Compton scattering	1	4
5.10	Relativistic dynamics	2	4
5.11	Magnetism as relativistic phenomenon	2	1,4
5.12	Transformation of fields	2	1,2,4
5.13	Field tensor	1	1,4
5.14	Electromagnetism in tensor notation	1	1,4
5.15	Relativistic potentials	1	4,5

Text Books:

1. Introduction to Electrodynamics, David J. Griffiths, PHI
2. Electromagnetic waves and radiating systems, E.C. Jordan & K.G. Balmain PHI, 1968
3. Antenna and waveguide propagation, K. D Prasad, SatyaPrakashan.

Reference Books:

1. Classical Electrodynamics, J. D. Jackson, Wiley Eastern Ltd.
2. Electromagnetic fields, S. Sivanagaraju, C. Srinivasa Rao, New Age International.
3. Introduction to Classical electrodynamics, Y. K. Lim, World Scientific, 1986.
4. Electromagnetic Waves and Fields, V.V. Sarwate, Wiley Eastern Ltd, New Age International
5. The Feynman Lectures in Physics, Vol. 2, R.P. Feynman, and R.B. Leighton & M. Sands.
6. Electronic Communication Systems, G. Kennedy & B. Davis, TMH.

Course	Details				
Code	PH1921103				
Title	**ELECTRONICS**				
Degree	M.Sc.				
Branch(s)	Physics				
Year/Semester	1/I				
Type	Core				
Credits	4	**Hours /week**	4	**Total Hours**	72

CO No.	**Expected Course Outcomes** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Explain the characteristics and applications of FET devices	U	1
2	Describe the concept of Op Amp as a differential amplifier	U	1,4
3	Differentiates between voltage series and voltage shunt feed-back amplifier	An	1,4
4	Illustrates the effects of thermal drift and variation in power supply voltage on offset voltage	A	1,2
5	Identifies the functions of integrator and differentiator	An	1
6	Describes the compensating circuits and different filter circuits	R	4
7	Compares the functions of oscillators and generators.	An	4,5
8	Interprets the limitations and functioning of Op Amp as a comparator	U	5,6
9	Explains analog modulation	U	1,6
10	Discuss the working of AM and FM receivers	E	6

PSO-Program specific outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO.No
1.0	**Semiconductor Devices &Op-amp with Negative Feedback**		
1.1	FET devices – structure	1	1
1.2	Characteristics and frequency dependence	2	1
1.3	Applications of FET devices	1	1
1.4	Op Amp-Differential amplifier – Inverting amplifier – Non-inverting amplifier	1.5	2
1.5	Block diagram representations	1.5	2
1.6	Voltage series feedback: Negative feedback	2	3

	– closed loop voltage gain – Difference input voltage ideally zero – Input and output resistance with feedback		
1.7	Bandwidth with feedback – Total output offset voltage with feedback – Voltage follower	1.5	3
1.8	Voltage shunt feedback amplifier: Closed loop voltage gain – inverting input terminal and virtual ground - input and output resistance with feedback –	2	3
1.9	Bandwidth with feedback - Total output offset voltage with feedback – Current to voltage converter- Inverter	1.5	3
1.10	Differential amplifier with one op-amp and two op-amps	2	2
2.0	**The Practical Op-amp and General Linear Applications (with design)**		
2.1	Input offset voltage –Input bias current – input offset current	1	4
2.2	Total output offset voltage- Thermal drift – Effect of variation in power supply voltage on offset voltage – Change in input offset voltage and input offset current with time	2	4
2.3	Noise – Common mode configuration and CMRR	1	4
2.4	DC and AC amplifiers – AC amplifier with single supply voltage	2	4
2.5	Peaking amplifier – Summing, Scaling, averaging amplifiers – Instrumentation amplifier using transducer bridge	2	4
2.6	Differential input and differential output amplifier – Low voltage DC and AC voltmeter	1.5	4
2.7	Voltage to current converter with grounded load	1.5	4
2.8	Current to voltage converter	1.5	4
2.9	Very high input impedance circuit – integrator and differentiator	1.5	5
3.0	**Frequency Response of an Op-amp Active Filters and Oscillators (with design)**		
3.1	Frequency response –Compensating networks – Frequency response of internally compensated and non-compensated op-amps	1	6
3.2	High frequency op amp equivalent circuit – Open loop gain as a function of frequency – Closed loop frequency response	2	6
3.3	Circuit stability - Slew rate.	1	6

3.4	Active filters – First order and second order low pass Butterworth filter	2	6
3.5	First order and second order high pass Butterworth filter		6
3.6	Wide and narrow band pass filter - wide and narrow band reject filter-	2	6
3.7	All pass filter	2	6
3.8	Oscillators: Phase shift and Wien-bridge oscillators	2	7
3.9	Square, triangular and sawtooth wave generators	2	7
3.10	Voltage controlled oscillator	2	7
4.0	**Comparators and Converters**		
4.1	Basic comparator	2	8
4.2	Zero crossing detector- Schmitt Trigger	2	8
4.3	Comparator characteristics	2	8
4.4	Limitations of op-amp as comparators	2	8
4.5	Voltage to frequency and frequency to voltage converters	2	8
4.6	D/A and A/D converters	2	8
5.0	**Analog Communication**		
5.1	Review of analog modulation	2	9
5.2	Radio receivers – AM receivers	2	10
5.3	Super heterodyne receiver	2	10
5.4	Detection and automatic gain control	2	10
5.5	Communication receiver – FM receiver	2	10
5.6	Phase discriminators – ratio detector	2	10
5.7	Stereo FM reception	2	10

Text Books:

1. Fundamentals of Semiconductor Devices, Betty Anderson Richard Anderson, TMH.
2. Op-amps and linear integrated circuits, R.A. Gayakwad 4th Edn. PHI.
3. Electronic Communication Systems, Kennedy & Davis 4th Ed.TMH.

Reference Books:

1. Electronic Devices (Electron Flow Version), 9/E Thomas L. Floyd, Pearson.
2. Fundamentals of Electronic Devices and Circuits 5th Ed. David A.Bell, Cambridge.
3. Electronic Communications Dennis Roddy and John Coolen, 4th Ed.Pearson.
4. Modern digital and analog communication systems, B.P. Lathi&Zhi Ding 4th Ed., Oxford University Press.
5. Linear Integrated Circuits and Op Amps, S Bali, TMH.

Course	Details				
Code	PH1921104				
Title	**MATHEMATICAL METHODS IN PHYSICS – I**				
Degree	M.Sc.				
Branch(s)	Physics				
Year/Semester	1/ I				
Type	Core				
Credits	3	**Hours/week**	3	**Total hours**	54

CO No.	**Expected Course Outcomes** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Familiarize the theorems in vector analysis and solve the mathematical problems related to the theorem	Ap	1
2	Differentiate between the types of matrices and to find the solution for linear equations	Ap	2,4
3	Explain the elementary probability theory and different theoretical distributions	An	3
4	Explain about tensors, its applications and properties	U	4
5	Familiarize tensor differentiation	Ap	4
6	Gain a working idea of groups	U	2

*PSO-Program specific outcome; CO-Course Outcome;
Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO. No
1.0	**Vectors and Vector Spaces**		
1.1	Review of Integral forms of gradient	1	1
1.2	Review of divergence and curl	2	1
1.3	Stoke's, Gauss's and Green's theorems	2	1
1.4	Scalar, vector, gravitational and centrifugal potentials	1	1
1.5	Orthogonal curvilinear coordinates	2	1
1.6	Gradient, divergence and curl in cartesian coordinates	2	1
1.7	Spherical and cylindrical coordinates	1	1
1.8	Equation of continuity	1	1
1.9	Linear vector spaces	1	1
1.10	Hermitian, unitary and projection operators with their properties, inner product space	2	1
1.11	Schmidt orthogonalization	1	1
1.12	Hilbert space - Schwartz inequality	2	1
2.0	**Matrices**		
2.1	Direct sum and direct product of matrices, diagonal matrices	1	2

2.2	Matrix inversion (Gauss-Jordan inversion method)	2	2
2.3	Orthogonal, unitary and Hermitian matrices, normal matrices, Pauli spin matrices	1	2
2.4	Cayley-Hamilton theorem	2	2
2.5	Similarity transformation - unitary and orthogonal transformation	2	2
2.6	Eigen values and eigenvectors	1	2
2.7	Diagonalisation using normalized Eigen vectors	2	2
2.8	Solution of linear equation- Gauss elimination method	2	2
2.9	Normal modes of vibrations	2	2
3.0	**Probability theory and distributions**		
3.1	Elementary probability theory, Random variables	1	3
3.2	Binomial, Poisson and Gaussian distributions	2	3
3.3	Central limit theorem	2	3
4.0	**Tensors**		
4.1	Definition of tensors, basic properties of tensors.	1	4
4.2	Covariant, contravariant and mixed tensors.	2	4
4.3	Levi-Civita Symbol, Metric tensor and its properties	1	4
4.4	Tensor algebra	1	4
4.5	Christoffel symbols	1	5
4.6	Covariant differentiation	2	5
4.7	Riemann-Christoffel tensor	2	5
5.0	**Group Theory**		
5.1	Definition of group	1	6
5.2	Discrete group (Examples)	1	6
5.3	Continuous group (Examples)	1	6
5.4	Matrix Groups	1	6
5.5	Special Unitary(2) group	1	6
5.6	Orthogonal(3) group	1	6

Text Books:

1. Mathematical methods for Physics and Engineering, K.F. Riley, M.P Hobson, S. J. Bence, Cambridge University Press (Chapter 24)
2. Mathematical Methods for Physicists, G.B. Arfken& H.J. Weber 4th Edition, Academic Press. (Chapter 19)
3. Elements of Group Theory for Physicists- A W Joshi

Reference Books:

1. Mathematical Physics, B.D. Gupta, Vikas Pub. House, New Delhi
2. Advanced Engineering Mathematics, E. Kreyszig, 7th Ed., John Wiley
3. Introduction to mathematical methods in physics, G. Fletcher, Tata McGraw Hill
4. Advanced engineering mathematics, C.R. Wylie, & L C Barrett, Tata McGraw Hill
5. Advanced Mathematics for Engineering and Physics, L.A. Pipes &L.R. Harvill, Tata McGraw Hill
6. Mathematical Methods in Physics, J. Mathew & R.L. Walker, India Book House.
7. Mathematical Physics, H.K. Dass, S. Chand & Co. New Delhi.

Course	Details				
Code	PH1921601				
Title	**GENERAL PHYSICS PRACTICAL**				
Degree	M.Sc.				
Branch(s)	Physics				
Year/Semester	I/ I				
Type	Core Practical				
Credits	4	**Hours/week**	10	**Total hours**	180

CO No.	**Expected Course Outcomes** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Describe the methodology of science and the relationship between observation and theory.	R	2
2	Practice the methodology by performing laboratory exercises.	Ap	2
3	Acquire necessary skills to produce accurate measurements and tabulate properly.	U	3
4	Understand data and draw inferences wisely.	An	4,6
5	Rediscover concepts of physics through optical and mechanical experiments.	E	3
6	Express their knowledge and ideas orally and in writing.	C	6

PSO-Program specific outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

(Minimum of 12 experiments should be done and recorded)

Section	Description	CO.No.
1.1	By Cornu's method, set up elliptical fringes and determine the Young's modulus and Poisson's ratio of the material of a bar. (Use either graphical method or calculations).	2
1.2	Set up an experiment to visualize the absorption bands of $KMnO_4$ using incandescent lamp, spectrometer and a prism. Determine the wavelengths of the absorption bands by evaluating Hartman's constants using standard mercury spectrum and scale & telescope arrangement.	2
1.3	Photograph/Record the absorption spectrum of iodine vapour and a standard spectrum. Analyze the given absorption spectrum of iodine vapour and determine the convergence limit. Also estimate the dissociation energy of iodine (wave number corresponding to the electronic energy gap = 759800 m^{-1})	4
1.4	Photograph/Record the spectrum of hydrogen and a	4

	standard spectrum. Analyze the given spectrum of hydrogen and calculate the Rydberg's constant.	
1.5	Photograph/Record the arc spectrum of iron or copper and a standard spectrum. Analyze the given arc spectrum of iron or copper and determine the wavelengths of the spectral lines evaluating the Hartmann's constants using wavelengths of the superimposed standard spectrum.	4
1.6	Verify the quantization of atomic energy levels using Franck Hertz technique and determine the first excitation potential of the gas.	5
1.7	Determine the Hall coefficient, carrier concentration and carrier mobility of a given specimen by Hall effect set up.	2
1.8	Determine the bandgap energy of the given semiconducting material by four probe method.	2
1.9	Determine the band gap energy of silicon/germanium using a forward/reverse biased p-n junction diode.	2
1.10	Determine the magnetic susceptibility of a paramagnetic solution by Quincke's method and hence prove that water is diamagnetic.	2
1.11	Determine the magnetic susceptibility of the given material using Gouy's method.	2
1.12	Determine the average wavelength of sodium D lines and the separation between them using a Michelson Interferometer	2
1.13	Determine the compressibility of the given liquid by generating an acoustic-grating in the liquid.	2
1.14	Draw the B-H curve of a ferromagnetic material and determine the retentivity and coercivity of the material.	5
1.15	Determine the co-efficient of viscosity of the given liquid by oscillating disc method.	4
1.16	Determination of the specific charge of the electron (e/m) from the path of an electron beam in crossed electric and magnetic fields of variable strength (Thomson method).	5
1.17	Draw the resistance-temperature characteristics of a thermistor and determine the temperature coefficient of resistance and the material parameter.	5
1.18	Determine the Young's modulus of the material of a bar by flexural vibrations.	4
1.19	Determine the Stefan's constant of radiation using a suitable method.	4
1.20	Measure the operating voltage of a GM counter and determine the linear absorption coefficient and half value thickness of a thin metal foil using a beta-ray source.	4
1.21	Using a multichannel analyzer study the energy spectrum of an alpha source.	5
1.22	Determine the Planck's constant using a photoelectric	4

	cell/LED.	
1.23	Determine the wavelength of the given laser source by observing the diffraction patterns of (a) cross wire and (b) wire mesh. (c) single slit (d) double slit (e) reflection grating (f) transmission grating (g) pin hole (h) single wire (any 4 compulsory)	4
1.24	Plot the beam profile of a given laser. Measure the spot size of the beam at three equidistant locations in the far-field and determine the half divergence angle.	5
1.25	Determine the numerical aperture of the given optical fibre from a measurement of its far field.	4
1.26	Study the macro bend-induced loss in the given optical fiber.	2
1.27	Determine the charge of an electron using Millikan oil drop experiment.	4
1.28	Measure the thermo emf of a given Cu-Fe thermocouple as function of temperature. Also prove that Seebeck effect is reversible	5
1.29	Verify the temperature dependence of ceramic capacitor and verify Curie-Weiss law	5

SEMESTER II

Course	Details				
Code	PH1922105				
Title	**MATHEMATICAL METHODS IN PHYSICS – II**				
Degree	M.Sc.				
Branch(s)	Physics				
Year/Semester	1/II				
Type	Core				
Credits	4	**Hours/week**	4	**Total Hours**	72

CO No.	**Expected Course Outcomes** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Comprehend the application of mathematical concepts needed to solve problems in physics as well as other areas of science, and acquire practical skills in the use of these methods	Ap	2
2	Explain the basic elements of complex mathematical analysis, including the integral theorems, obtain the residues of a complex function and use the residue theorem to evaluate definite integrals in solving physical problems	Ap	2, 4
3	Apply integral transform (Fourier and Laplace) to solve mathematical problems of interest in physics	Ap	4, 7
4	Apply functions like Alpha, Beta, Dirac Delta, Gamma and Green function to solve mathematical problems of interest in physics	Ap	4
5	Solve partial differential equations that are common in physical sciences by making use of standard methods like separation of variables	An	4, 7
6	Identify second order linear differential equation and find the linear independent solutions	An	4
7	Elaborate the orthogonal polynomials of special functions	C	4

PSO-Program specific outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO. No.
1.0	**Complex Analysis**		
1.1	Functions of a complex variable	1	1,2
1.2	Analytic functions	1	1,2
1.3	Cauchy-Riemann equation	2	2
1.4	Cauchy’s theorem	1	2

1.5	Cauchy’s integral formula	1	2
1.6	Taylor expansion	2	2
1.7	Laurent expansion	2	2
1.8	Poles and residues	2	2
1.9	Residue theorem	2	2
1.10	Cauchy’s principle value theorem	2	2
1.11	Evaluation of integrals	2	2
2.0	**Integral Transforms**		
2.1	Introduction to Fourier series and Fourier integral form	1	1, 3
2.2	Fourier transform: Properties	1	1, 3
2.3	Applications: square wave	1	1, 3
2.4	Applications: full wave rectifier	1	1, 3
2.5	Applications: finite wave train	1	1, 3
2.6	Fourier sine and cosine transforms	1	1, 3
2.7	Momentum representation of hydrogen atom ground state and harmonic oscillator	1	1, 3
2.8	Laplace transform – Properties	1	1, 3
2.9	Laplace transform – Applications: Earth’s nutation	1	1, 3
2.10	LCR circuit	2	1, 3
2.11	Damped, driven oscillator	2	1, 3
2.12	Inverse Laplace transform	1	1, 3
2.13	Solution of differential equations	2	1, 3
3.0	**Partial Differential Equations**		
3.1	Characteristics and boundary conditions for partial differential equations	1	1, 5
3.2	Separation of variables in Cartesian, cylindrical and spherical polar coordinates	2	1, 5
3.3	Heat equation	1	1, 5
3.4	Laplace’s equation	1	1, 5
3.5	Poisson’s equation	2	1, 5
3.6	Non homogeneous equation - Green’s function	1	1, 4
3.7	General form of Green’s function for a self adjoint differential operator	1	1, 4
3.8	Symmetry of Green’s function	1	1, 4
3.9	Green’s function for Poisson equation	1	1, 4
3.10	Helmholtz equation	1	1, 4
3.11	Forms of Green function	1	1, 4
3.12	Application of Green’s function in scattering problem	1	1, 4
4.0	**Special Functions - I**		

4.1	Gamma and Beta functions	1	4
4.2	Different forms of beta and gamma functions	1	4
4.3	Evaluation of standard integrals	1	4
4.4	Dirac delta function - properties	1	1, 4
4.5	Bessel's differential equation -	1	1, 6
4.6	Generating function	1	1, 6
4.7	Recurrence relations	1	1, 6
4.8	Orthogonality condition	1	7
4.9	Rodrigue's formula	1	6
5.0	**Special Functions - II**		
5.1	Legendre differential equation - solution	1	1, 6
5.2	Generating function	1	1, 6
5.3	Recurrence relations	1	1, 6
5.4	Orthogonality condition	1	7
5.5	Rodrigue's formula	1	6
5.6	Hermite differential equation - solution	1	6
5.7	Generating function	1	6
5.8	Recurrence relations	1	6
5.9	Orthogonality condition	1	7
5.10	Rodrigue's formula	1	6
5.11	Laguerre differential equation - solution	1	6
5.12	Generating function	1	6
5.13	Recurrence relations	1	1, 6
5.14	Orthogonality condition	1	7
5.15	Rodrigue's formula	1	1, 6

Text Books:

1. Mathematical Methods for Physicists, G.B. Arfken& H.J. Weber, 4th Edition, Academic Press.
2. Introduction to Mathematical Physics, Charlie Harper, PHI.
3. Mathematical Physics, B.D. Gupta, VikasPub.House, New Delhi
4. Mathematical Physics, B.S Rajput, PragatiPrakashan.
5. Mathematical Physics, Satya Prakash, S.Chand& Sons.

Reference Books:

1. Advanced Engineering Mathematics, E. Kreyszig, 7th Ed., John Wiley.
2. Introduction to mathematical methods in physics, G. Fletcher, Tata McGraw Hill.
3. Advanced engineering mathematics, C.R. Wylie, & L C Barrett, Tata McGraw Hill.
4. Advanced Mathematics for Engineering and Physics, L.A. Pipes & L.R. Harvill, Tata McGraw Hill.
5. Mathematical Methods in Physics, J. Mathew & R.L. Walker, India Book House.
6. Mathematical Physics, H.K. Dass, S. Chand & Co. New Delhi.

Course	Details				
Code	PH1922106				
Title	**THERMODYNAMICS AND STATISTICAL MECHANICS**				
Degree	M.Sc.				
Branch(s)	Physics				
Year/Semester	1/ II				
Type	Core				
Credits	4	**Hours/week**	4	**Total hours**	72

CO No.	**Expected Course Outcomes** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Explain the fundamentals of thermodynamics, Carnot cycle, statistics and distributions.	U	1,6
2	Grasp the basis of ensemble approach in statistical mechanics to a range of situations.	An	1,3
3	Explain the fundamental differences between classical and quantum statistics and learn about quantum statistical distribution laws.	U	1,3,5
4	Analyze important examples of ideal Bose systems and Fermi systems.	An	1,2
5	Discuss various phenomena in solids using statistical mechanics.	Ap	1,4`
6	Develop and apply Ising model and mean field theory for first and second order phase transitions.	Ap	1,4

PSO-Program specific outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO.No.
1.0	**Fundamental of thermodynamics**		
1.1	Fundamental definitions & different aspects of equilibrium	2	1
1.2	Functions of state-Internal energy, Enthalpy and heat capacities	2	1

1.3	Reversible Changes, Reversible adiabatic changes in an ideal gas	1	1
1.4	Second law of thermodynamics, The Carnot cycle, Equivalence of absolute and perfect gas scale of temperature	2	1
1.5	Entropy- Definition, measuring, law of increase, calculation of its increase in irreversible processes	2	1
1.6	Ideas about probability	1	1,3
1.7	Axioms of probability, independent events	1	1,3
1.8	Statistics and distribution	1	1,3
1.9	Basic ideas of statistical mechanics	1	1
1.10	Definition of the quantum state of the system	1	1
1.11	Simple model of spins on lattice sites	2	1
1.12	Equations of state	1	1
2.0	**The Canonical Ensemble**		
2.1	System in contact with a heat bath	1	2
2.2	Definition of the entropy in the canonical ensemble	1	2
2.3	The partition function, the bridge to thermodynamics through partition function & condition for thermal equilibrium	3	2
2.4	Thermodynamic quantities from partition function	2	1,2
2.5	Two level system	1	2
2.6	Single particle in 1-D and 3-D box	2	2
2.7	Expression for heat and work	1	2
2.8	Rotational and vibrational energy levels for diatomic molecules	3	2
2.9	Factorizing the partition function	1	1,2
2.10	Equipartition theorem	1	2
2.11	Minimizing the free energy	1	2
3.0	**Maxwell Distribution and Planck's Distribution**		
3.1	Density of states in k space and energy space	1	1
3.2	Distribution of speeds of particles in a classical gas	2	1,3
3.3	Blackbody radiation	2	1,4
3.4	Rayleigh-Jeans theory	1	1
3.5	Planck's distribution	2	1
3.6	Einstein's and Debye's model of vibrations in a solid	2	1,5
4.0	**Statistics of Identical Particles**		

	&Grand Canonical Ensemble		
4.1	Identical particles- symmetric a antisymmetricwavefunctions	1	2,3
4.2	Bosons and Fermions	1	2,3
4.3	Calculating the partition function identical particles	1	2,3
4.4	Spin	1	2
4.5	Identical particles localized on lattice sites.	1	2
4.6	Systems with variable number of particles	1	2
4.7	The condition for chemical equilibrium – the approach to chemical equilibrium – chemical potential	1	2
4.8	Reactions and external chemical potential	1	2
4.9	Grand canonical ensemble and its partition function	1	2
4.10	Adsorption of atoms on surface sites	1	2
4.11	Grand potential	1	2
5.0	**Fermi and Bose Particles & Phase Transitions**		
5.1	Statistical mechanics of identical particles	2	2,3
5.2	Examples of Fermi systems	1	2,3
5.3	Non-interacting Bose gas	2	2,3
5.4	Phases	1	5,6
5.5	Thermodynamic potential	1	5,6
5.6	First order phase transition	1	5,6
5.7	Clapeyron equation	1	6
5.8	Phase separation	1	5,6
5.9	Phase separation in mixtures	2	5,6
5.10	Liquid gas system	1	6
5.11	Isingmodel , order parameter	1	6
5.12	Landau theory	1	6
5.13	Symmetry breaking field, critical exponent	2	6

Text Books:

1. Introductory Statistical Mechanics, R. Bowley&M.Sanchez, 2nd Edn. 2007, Oxford University Press, Indian Edition
2. Statistical Mechanics, R.K. Pathria, & P.D. Beale, 2nd Edn, B-H (Elsevier) (2004).

Reference Books:

1. Introductory Statistical Physics, S.R.A. Salinas, Springer (2000).
2. Fundamentals of Statistical and Thermal Physics, F. Rief, McGraw Hill (1986).
3. Statistical Mechanics, Kerson Huang, John Wiley and Sons (2003).
4. Statistical Mechanics, Satyaprakash& Agarwal, KedarNath Ram Nath Pub. (2004).

5. Problems and solutions on Thermodynamics and Statistical mechanics, Yung Kuo Lim, World Scientific Pub. (1990)
6. Fundamentals of Statistical Mechanics, A.K. Dasgupta, New Central Book Agency Pub. (2005)
7. Statistical Mechanics: a survival guide, A.M. Glazer and J.S. Wark, Oxford University Press. (2001).

Course	Details				
Code	PH1922107				
Title	**CONDENSED MATTER PHYSICS**				
Degree	M.Sc.				
Branch(s)	Physics				
Year/Semester	1/II				
Type	Core				
Credits	4	**Hrs/Week**	4	**Total hours**	72

CO No.	**Expected Course Outcomes** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Recognize different types of Materials and their Classification	R	1,3
2	Explain the Free Electron Theory of Metals	U	1, 3
3	Interpret Band Theory of Metals and semiconductors	Ap	1,4
4	Discuss the Dielectric Properties of Solids	E	1,3
5	Analyze the Magneticbehaviour of solids	An	5
6	Explain the Superconductivity phenomena and related theorems	An	1, 4
7	Solve problems related to metals, semiconductors, dielectric materials, magnetic materials and superconductivity	Ap	2,4,6

PSO-Program specific outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO No
1.0	**Wave diffraction, reciprocal lattice & Free Electron Theory of Metals**		
1.1	Recent developments in condensed matter physics	1	8
1.2	Bragg's equation, scattered wave amplitude	1	1,2,7
1.3	the reciprocal lattice, diffraction conditions	1	1,2,7
1.4	Laue equations	1	1,2,7
1.5	Brillouin zones- reciprocal lattice to Simple Cubic lattice, Base Centered Cubic and Face Centered Cubic lattices	2	1,2,7
1.6	Fourier analysis of the basis-structure factor of bcc and fcc lattice, atomic form factor	2	1,2,7
1.7	Energy levels in one dimension	2	1,2,7
1.8	Effect of temperature on Fermi Dirac distribution	1	1,2,7

1.9	Free electron gas in three dimension	1	1,2,7
1.10	Heat capacity of the electron gas-experimental heat capacity of metals-heavy fermions	2	1,2,7
1.11	Electrical conductivity and Ohm's law	1	1,2,7
1.12	Motion in magnetic field	2	1,2,7
1.13	Thermal conductivity of metals	1	1,2,76
2.0	**Band Theory of Metals & Semiconductor crystals**		
2.1	Nearly free electron model-Bloch functions,	2	1,3,7
2.2	Kronig-Penney model –wave equations of the electron in a periodic potential-restatement of the Bloch theorem	2	1,3,7
2.3	Crystal momentum of an electron- solution of the central equation	2	1,3,7
2.4	Kronig Penney model in Reciprocal Space	2	1,3,7
2.5	Number of orbitals in a band Extended zone scheme-Reduced Zone scheme-periodic zone scheme	2	1,3,7
2.6	Band gap-equation of motion	2	1,3,7
2.7	Physical derivation of momentum	1	1,3,7
2.8	Holes-Effective mass- physical interpretation-effective masses in semiconductors-	2	1,3,7
2.9	Intrinsic carrier concentration-impurity conductivity	2	1,3,7
2.10	Thermoelectric effect	1	1,3,7
3.0	**Lattice Dynamics and Dielectric Properties of Solids**		
3.1	Vibrations of crystals with monatomic basis	2	1,4,7
3.2	First Brillouin zone, group velocity, diatomic lattice	2	1,4,7
3.3	Quantization of elastic waves	1	1,4,7
3.4	Phonon momentum -Phonon heat capacity-Planck distribution, normal mode enumeration	2	1,4,7
3.5	Density of states in 1D and 3D	2	1,4,7
3.6	Einstein model, Debye model - Debye T^3 law	1	1,4,7
3.7	An harmonic crystal interactions	2	1,4,7
3.8	Thermal conductivity-thermal resistivity of phonon gas,	2	1,4,7
3.9	Umklapp process	1	1,4,7
3.10	Dielectrics- polarization, macroscopic electric field	1	1,4,7
3.11	Local electric field at an atom	1	1,4,7
3.11	Dielectric constant and polarizability	1	1,4,7
4.0	**Magnetic properties of solids**		
4.1	Langevin diamagnetism equation	1	1,5,7
4.2	Quantum theory of diamagnetism of Mononuclear systems,	1	1,5,7
4.3	Quantum theory of paramagnetism, rare earth ions	2	1,5,7

4.4	Hund's rules -cooling by adiabatic demagnetization	1	1,5,7
4.5	Ferromagnetic order- curie point and the exchange integral	1	1,5,7
4.6	Temperature dependence of the saturation magnetization	1	1,5,7
4.7	Magnons -quantization of spin waves	2	1,5,7
4.8	Ferromagnetic domains-anisotropy energy	1	1,5,7
4.9	transition region between domains	1	1,5,7
4.10	Origin of domains-coercivity and hysteresis	1	1,5,7
5.0	**Superconductivity**		
5.1	Thermodynamics and electrodynamics of superconducting transition	1	1,6,7
5.2	London equations - coherence length	1	1,6,7
5.3	BCS theory – BCS ground state	1	1,6,7
5.4	Energy gap- flux quantization - Single particle tunneling	1	1,6,7
5.5	Josephson superconductor tunneling, Macroscopic quantum interference	1	1,6,7
5.6	High Tc superconductivity and its applications.	1	1,6,7

Text Books:

1. Introduction to Solid State Physics, C. Kittel, 8thEdn. Wiley India.

Reference Books:

1. Solid State Physics, N.W. Ashcroft & N.D. Mermin, Cengage Learning Pub.11th Indian Reprint (2011).
2. Solid State Physics, A.J. Dekker, Macmillan & Co Ltd. (1967)
3. Elementary Solid State Physics, M. Ali Omar, Pearson, 4th Indian Reprint (2004).
4. Solid State Physics, R.L. Singhal, KedarNath Ram Nath& Co (1981)
5. Solid State Physics, C.M. Kachhava, Tata McGraw-Hill (1990).
6. Elements of Solid State Physics, J. P. Srivastava, PHI (2004)
7. Solid State Physics, Dan Wei, Cengage Learning (2008)
8. Solid State Physics, S.O. Pillai, New Age International 6th Edn. 2010
9. Solid State Physics: Structure and properties of materials, M.A. Wahab, Narosa 2ndEdn. 2010.

Course	Details				
Code	PH1922108				
Title	**QUANTUM MECHANICS I**				
Degree	M.Sc.				
Branch(s)	Physics				
Year/Semester	1/II				
Type	Core				
Credits	3	Hrs/Week	3	Total hours	54

CO No.	**Expected Course Outcomes** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Explain mathematical tools of Quantum Mechanics	U	1,2
2	Apply Dirac formulation to state kets, operators and bras	Ap	1
3	Analyze general formalism of quantum mechanics of various problems	An	1,3
4	Explain measurements, observables and uncertainty relations	E	1,2
5	Discuss the representation in continuous basis	An	1,2
6	Analyze the Quantum Dynamics of a system	An	1,2
7	Explain the general formalism of angular momentum	An	1,2
8	Discuss rotations and angular momentum	U	1,2
9	Evaluate the addition of two spin angular momenta	E	1,2

PSO-Program specific outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO.No.
1.0	**Basics of the Dirac Formulation of Quantum Mechanics-I**		
1.1	Dirac notation for state vectors: ket space, bra space, inner products	1	1,2
1.2	Operators-Associative Axiom- Outer product	1	1,2
1.3	Hermitianadjoint- Hermitian operator- Eigenkets and eigenvalues of Hermitian operators	1	1,2
1.4	Eigenkets of observables as base kets	1	1,2
1.5	Concept of complete set- projection operators	1	1,2
1.6	Matrix representation of operators, kets and bras	2	1,2
1.7	Matrix representation of state kets and spin operators of spin half systems.	1	1,2,3
2.0	**Basics of the Dirac Formulation of Quantum Mechanics-II**		
2.1	Measurements- expectation value	1	1,4
2.2	Compatible observables and existence of simultaneous eigenkets	1	1,2,4
2.3	Generalized uncertainty relation	1	1,4
2.4	Unitary operator — change of basis- orthonormal basis and unitary matrix, transformation matrix-unitary	1	1,2,4

	equivalent observables		
2.5	Eigenkets of position-infinitesimal operator and its properties – linear momentum as generator of translation – canonical commutation relations	1	1,2,5
2.6	Properties of wave function in position space and momentum space - relations between operator formalism and wave function formalism	2	1,5
2.7	Momentum operator in position basis – momentum space wave function	1	1,2,5
2.8	Computation of expectation values x, x^2, p and p^2 for a Gaussian wave packet	2	3,5
3.0	**Quantum Dynamics**		
3.1	Time evolution operator and its properties	2	6
3.2	Time evolution and Schrodinger equation - Solution of the Schrodinger equation for different time dependence of the Hamiltonian	2	6
3.3	Energy eigenkets - time dependence of expectation values	2	6
3.4	Time energy uncertainty relation	2	6
3.5	Schrodinger picture and Heisenberg picture - behaviour of state kets and observables in Schrodinger picture and Heisenberg picture	2	6
3.6	Heisenberg equation of motion - Ehrenfest's theorem	2	6
3.7	Time evolution of base kets - transition amplitude		6
3.8	Energy eigenket and eigen values of a simple harmonic oscillator using creation and annihilation operator	2	3,6
4.0	**Quantum Mechanics in Three Dimensions, Angular Momentum- I**		
4.1	Schrodinger equation in spherical coordinates, The Hydrogen atom: Radial part of the hydrogen wave function	2	3
4.2	Hydrogen atom: Angular part of the hydrogen wave function	1	3
4.3	Orbital Angular momentum- Eigen functions and eigen values of the L^2 and L_z operators	1	7
4.4	General formalism of angular momentum	2	7
4.5	Ladder operators	1	7
4.6	Eigen states and eigen values of angular momentum operator	1	7
4.7	Matrix representation of Angular Momentum operators	2	7
4.8	Spin angular momentum – general theory of spin, Spin ½ and Pauli matrices	2	3,7
5.0	**Angular Momentum- II**		
5.1	Rotations and angular momentum commutation relations-Finite versus infinitesimal rotation	2	7,8
5.2	Infinitesimal rotations in Quantum Mechanics	1	7,8
5.3	Rotation operator for spin ½ system	1	7,8
5.4	Representation of rotation operator- properties of	2	7,8

	rotation operator		
5.5	Calculation of Clebsch-Gordan coefficients for two spin ½ particles	2	3,7,9

Text Books:

1. Modern Quantum Mechanics, J.J. Sakurai, Pearson Education
2. Quantum Mechanics, Concepts and Applications, N. Zettili, John Wiley & Sons.
3. Introduction to Quantum Mechanics, D.J. Griffiths, Pearson Education

References Books:

1 A Modern approach to quantum mechanics, John S. Townsend, Viva Books MGH.
2 Basic Quantum Mechanics, A. Ghatak, Macmillan India 1996
3 Quantum Mechanics, An Introduction, W Greiner, Springer Verlag
4 Quantum Mechanics, E. Merzbacher, John Wiley, 1996
5 Quantum Mechanics, G. Aruldhas, Prentice Hall of India private Limited
6 Quantum Mechanics, L.I. Schiff, Tata McGraw Hill
7 A Text Book of Quantum Mechanics, P.M. Mathews & K. Venkatesan, TMGH.
8 Fundamentals of Quantum Mechanics Y.R. Waghmare, S Chand & Co.
9. Quantum Mechanics-V. K. Thankappan, New Age Int. Pub

Course	Details				
Code	PH1922602				
Title	**ELECTRONICS PRACTICAL**				
Degree	M.Sc.				
Branch(s)	Physics				
Year/Semester	1/ II				
Type	Core Practical				
Credits	4	**Hours/week**	10	**Total hours**	180

CO No.	**Expected Course Outcomes** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	To understand the principle and working of different amplifiers, oscillators, filters, converters, op amp and FETs	U	3,6
2	Design the different oscillator, filter, amplifier circuits for various frequencies	C	2,3
3	Select the appropriate integrated circuit modules to build a given application.	E	2,3
4	Design FET/ MOSFET based circuits	C	3
5	Create amplitude modulation generation and demodulation circuits	C	3,6

PSO-Program specific outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

(Minimum of 12 experiments should be done and recorded)

Section	Description	CO.No.
1.1	R C Coupled CE amplifier - Two stages with feedback - Frequency response and voltage gain.	1,2
1.2	Differential amplifiers using transistors and constant current source - Frequency response, CMRR.	1,2
1.3	Push-pull amplifier using complementary - symmetry transistor power gain and frequency response.	1,2
1.4	R F amplifier - frequency response & band width - Effect of damping.	1,2
1.5	Voltage controlled oscillator using transistors.	1,2
1.6	Voltage controlled oscillator using IC 555	1,2
1.7	R F Oscillator - above 1 MHz frequency measurement.	1,2
1.8	Differential amplifier - using op-amp.	1,2
1.9	Active filters – first and second order -low pass -frequency response and roll off rate.	1,2
1.10	Active filters – first and second order -high pass - frequency response and roll off rate.	1,2
1.11	Band pass filter using single op-amp-frequency response and bandwidth.	1,2

1.12	Wein-bridge Oscillator – using op-amp with amplitude stabilization.	1,2
1.13	Crystal Oscillator	1,2
1.14	RC phase shift oscillator using op-amp	1,2
1.15	AM generation and demodulation	5
1.16	Solving differential equation using IC 741	3
1.17	Solving simultaneous equation using IC 741	3
1.18	Current to voltage and voltage to current converter (IC 741)	1, 3
1.19	Triangular wave generator using Op-amp with specified amplitude.	1
1.20	Analog to digital and digital to analog converter ADC0800 & DAC0800	1
1.21	Applications of op-amp- comparator,zero crossing detector, Schmitt trigger	1
1.22	FET / MOSFET characteristics and amplifier design	1,4

SEMESTER III

Course	Details				
Code	PH1923109				
Title	**QUANTUM MECHANICS II**				
Degree	M.Sc.				
Branch(s)	Physics				
Year/Semester	II/III				
Type	Core				
Credits	4	**Hours/week**	4	**Total Hours**	72

CO No.	**Expected Course Outcomes** *Upon completion of this course, the students will be able to:*	Cognitive Level	PSO No.
1`	Determine low-order energy corrections caused by small perturbations to the Hamiltonian.	E	1,2
2	Apply fundamental quantum mechanical calculation methods such as the variation method, WKB method stationary and time-dependent perturbation theory, scattering theory	Ap	1,2
3.	Discuss andanalyze in detail the theory of relativistic quantum mechanics	An	1,2
4.	Explain the Dirac equation and its free-particle solutions and the existence of antiparticles.	U	1,2
5.	Show the relativistic covariance of Dirac equation	Ap	1,2
6.	Analyze the constancy of motion of a physical quantity	An	1

PSO-Program specific outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO.No.
1.0	**Time independent perturbation theory**		
1.1	Non-degenerate perturbation theory: First order correction to energy and energy eigenstate, Second order energy shift.	2	1,2
1.2	Harmonic Oscillator subjected to a constant electric field	2	1,2
1.3	Quadratic stark effect	1	
1.4	Degenerate perturbation theory:First order Stark effect in Hydrogen	2	1,2
1.5	Zeeman effect in Hydrogen	2	1,2
2.0	**The Variational Method and The WKB Method**		
2.1	The variational method, Estimation of ground state energy of Harmonic Oscillator.	2	2

2.2	Estimation of ground state energy of Hydrogen atom	1	2
2.3	The WKB method, The Connection formulas	2	2
2.4	Validity of WKB method, Barrier penetration, Potential well	2	2
2.5	Quantization condition, Harmonic Oscillator	2	2
3.0	**Time Dependent Perturbation Theory**		
3.1	Time dependent potentials - interaction picture	2	2
3.2	Time evolution operator in interaction picture	1	2
3.3	Equation of motion for state kets and operator	2	2
3.4	Time dependent perturbation theory - Dyson series	2	2
3.5	Transition probability - constant perturbation	2	2
3.6	Fermi’s Golden rule	1	2
3.7	Transition probability - harmonic perturbation	2	2
3.8	Interaction with classical radiation field - absorption and stimulated emission	2	2
3.9	Electric dipole approximation	2	2
3.10	Sudden and adiabatic approximation.	2	2
4.0	**Scattering**		
4.1	Scattering amplitude and differential cross section	2	2
4.2	Asymptotic limit of the wave function	1	2
4.3	Born approximation	2	2
4.4	Validity of Born approximation	1	2
4.5	Yukawa potential	1	2
4.6	Rutherford scattering	1	2
4.7	The partial wave expansion	3	2
4.8	Hard sphere scattering	3	2
4.9	S-wave scattering for the finite potential well	2	2
4.10	Resonances	1	2
4.11	Ramsauer- Townsend effect	1	2
5.0	**Relativistic Quantum Mechanics**		
5.1	Need for relativistic wave equation	1	3
5.2	Klein-Gordon equation	2	3
5.3	Probability conservation	1	3
5.4	Covariant notation and solution of K.G equation	1	3
5.5	Derivation of Dirac equation	2	3
5.6	Conserved current representation	1	3
5.7	Free particle at rest	1	4
5.8	Plane wave solutions	2	4
5.9	Gamma matrices	2	4
5.10	Relativistic covariance of Dirac equation	2	5
5.11	Angular momentum as constant of motion,	1	6
5.12	Dirac’s hole theory	2	3

Text Books:

1. Advanced Quantum Mechanics, J.J. Sakurai, Pearson Education
2. A Modern Approach to Quantum Mechanics, John S. Townsend, Viva Books Pvt Ltd, MGH
3. Modern Quantum Mechanics: J.J Sakurai,Pearson Education

Reference Books:

1. Quantum Mechanics: Concepts and Applications:NouredineZettili
2. Introduction to Quantum Mechanics: David J Griffiths,Prentice Hall New
3. Relativistic Quantum Mechanics: Walter Greiner,Springer-Verlag
4. Quantum Mechanics: V.K Thankappan , New Age International
5. Quantum Mechanics (Schaum's Outline Series): YoavPelegetal, Tata Mcgraw Hill education Private Limited
6. QuantumMechanics: NonRelativistic Theory (Course of Theoretical Physics Course Vol 3): LD Landau and E.M.Lifshiftz,Pregamon Press.

Course	Details				
Code	PH1923110				
Title	**COMPUTATIONAL PHYSICS**				
Degree	M.Sc.				
Branch(s)	Physics				
Year/Semester	II/III				
Type	Core				
Credits	4	**Hours/week**	4	**TotalHours**	72

CO No.	**Expected Course Outcomes** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Analyze data using curve fitting	An	1
2	Estimating the missing data through interpolation methods	Ap	2
3	Discuss the numerical methods of integration and differentiation	U	1,2
4	Apply numerical methods of integration and differentiation to get approximate solutions to mathematical problems	Ap	3,4
5	Apply numerical methods to obtain approximate solutions to mathematical problems.	Ap	5
6	Derive numerical methods for the solution of linear and nonlinear equations, and the solution of differential equations.	U	5
7	Understand mathematical methods in physics and their application	U	3
8	Understand finite difference method for solving partial differential equations	U	5
9	Understand the logic of statistical testing	U	5

PSO-Program specific outcome; CO-Course Outcome; Cognitive Level:
R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO. No.
1.0	**Curve Fitting and Interpolation**		
1.1	The least squares method for fitting a - straight line	2	1
1.2	The least squares method for fitting a - Parabola	2	1
1.3	The least squares method for fitting a - Power	1	1
1.4	The least squares method for fitting - Exponential curves	2	1

1.5	Interpolation - Introduction to finite difference operators	2	2, 8
1.6	Newton's forward difference interpolation formulae	2	2, 8
1.7	Newton's backward difference interpolation formulae	2	2, 8
1.8	Lagrange's interpolation formula	2	2, 8
1.9	Newton's divided difference formula with error term	2	2, 8
1.10	Interpolation in two dimensions	2	2, 8
1.11	Statistical tests - χ^2- test and T-test (qualitative ideas)	1	9
2.0	**Numerical Differentiation and Integration**		
2.1	Numerical differentiation	1	3
2.2	Newton's forward and backward formula	2	3,4
2.3	Errors in numerical differentiation	1	3,4
2.4	Finding maxima and minima of a tabulated function	2	3,4
2.5	Cubic spline method	2	3,4
2.6	Integration of a function using Trapezoidal Rule	2	3,4
2.7	Simpson's 1/3 and 3/8 Rule Error associated with each rule	2	3,4
2.8	Romberg's integration	1	3,4
2.9	Gaussian integration method	1	3,4
2.10	Numerical double integration	2	3,4
3.0	**Numerical Solution of Ordinary Differential Equations**		
3.1	Euler method	1	5,6
3.2	Modified Euler method	1	5,6
3.3	Runge - Kutta method	1	5,6
3.4	Adaptive step size R-K method	1	5,6
3.5	Predictor - corrector methods	2	5
3.6	Milne's method	2	5
3.7	Adam-Moulton method	2	5
4.0	**Numerical Solution of System of Equations**		
4.1	Gauss-Jordan elimination Method	2	5
4.2	Gauss-Seidel iteration method	2	5
4.3	Gauss elimination method	2	5
4.4	Gauss-Jordan method to find inverse of a matrix	2	5
4.5	Power method	2	5
4.6	Jacobi's method to solve eigen value problems	2	5

5.0	**Numerical solutions of partial differential equations**		
5.1	Elementary ideas	2	7
5.2	Basic concepts in finite difference method	2	7,8
5.3	Schmidt method	3	7,8
5.4	Crank-Nicholson method	3	7,8
5.5	Weighted average implicit method	2	7,8
5.6	Concept of stability	2	7

Text Books:

1. Mathematical Methods, G. Shanker Rao, K. Keshava Reddy, I.K. International Publishing House, Pvt. Ltd.
2. Introductory Methods of Numerical Analysis, S.S. Sastry, PHI Pvt. Ltd.
3. Numerical Methods,P. Kandasamy ,K .Thilagavathy,K. Gunavathy
4. Numerical Methods for Scientists and Engineers, K. Sankara Rao, PHI, 3rd Edition.

Reference Books:

1. An Introduction to Computational Physics, Tao Pang, Cambridge University Press
2. Numerical methods for scientific and Engineering computation M.K Jain,S.R.K. Iyengar, R.K. Jain, New Age International Publishers
3. Computer Oriented Numerical Methods, V. Rajaraman, PHI, 2004.
4. Numerical Methods, E. Balagurusami, Tata McGraw Hill, 2009.
5. Numerical Mathematical Analysis, J.B. Scarborough, 4th Edn, 1958.

Course	Details				
Code	PH1923603				
Title	**COMPUTATIONAL PHYSICS – PRACTICAL**				
Degree	M.Sc.				
Branch(s)	Physics				
Year/Semester	II/ III				
Type	Core Practical				
Credits	4	**Hours/week**	10	**Total hours**	180

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Develop C++ programs for numerical problems	C	2,4
2	Solve computational problems using numerical methods	C	4
3	Use C++ program for interpolating data	Ap	2
4	Create program to fit appropriate curve to a given set of data	C	2,3
5	Evaluate derivatives and integrals of functions	E	2
6	Create C++ program to solve differential equations.	C	3,4
7	Develop C++ program to solve Runge-Kutta and Monte Carlo methods	An	2
8	Develop C++ program to find solution of diffusion equation	An	2,4

PSO-Program specific outcome; CO-Course Outcome; Cognitive Level:
R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create
(Minimum of 12 experiments should be done and recorded)

Section	Description	CO.No.
1.1	Zeros of the Legendre Polynomials $P_n(x)$ (or roots ofthe equation $P_n(x) = 0$ or nodes of the Gauss-Legendre quadrature), $2 < n < 6$.	1
1.2	Zeroes of the Laguerre Polynomials $L_n(x)$ (or roots of the equation $L_n(x) = 0$ or nodes of the Gauss-Laguerre quadrature), $2 < n < 6$.	1
1.3	Zeroes of polynomials by the bisection method	2
1.4	Zeroes of polynomials/non-linear equations by the Newton-Raphson method	2
1.5	Lagrange interpolation.	3
1.6	Newton forward interpolation.	3
1.7	Newton backward interpolation.	3
1.8	Curve-fitting: Least-squares fitting.	4
1.9	Numerical integration by the trapezoidal rule.	5
1.10	Numerical integration by the Simpson rule.	5
1.11	Numerical integration using Romberg's method.	5
1.12	Numerical solution of ordinary first-order differential equations using the Euler methods.	6
1.13	Numerical solution of ordinary first-order differential equations using the fourth order Runge-Kutta method.	6
1.14	Solution of ODE using Milne's predictor – corrector method.	6
1.15	Solution of ODE using Adam's predictor – corrector method.	6
1.16	Numerical solution of second-order differential equations using the fourth order Runge-Kutta method.	7
1.17	Monte Carlo methods for solving 2D Ising model on a square lattice.	7
1.18	Fast Fourier Transform of a given signal.	1,7
1.19	Solution of Heat equation using Finite Difference Method.	8
1.20	Solution of Diffusion equation using Finite Difference Method.	8
1.21	Simulation of Chaos.	1

Reference Books

1. Computational Physics: An Introduction, R.C. Verma, P.K. Ahluwalia & K.C. Sharma, New Age India, Pvt. Ltd (2014).
2. An Introduction To Computational Physics, 2nd Edn, Tao Pang Cambridge University Press (2010)
3. Numerical Recipes: The Art of Scientific Computing 3rd Edn, William H. Press Cambridge University Press, (2007).

SEMESTER IV

Course	Details				
Code	PH1924111				
Title	**ATOMIC AND MOLECULAR PHYSICS**				
Degree	M.Sc.				
Branch(s)	Physics				
Year/Semester	II/IV				
Type	Core				
Credits	4	**Hours/week**	4	**Total Hours**	72

CO No	**Expected Course Outcomes** *Upon completion of this course, the students will be able to:*	Cognitive Level	PSO No.
1	Understand the theory of atomic spectra	U	1
2	Explain the concept of spin-orbit interaction	U	1,2
3	Discuss Zeeman effect, Stark effect and Paschen Back effect	U	2,3
4	Explain the rotation spectra of different molecules	A	1,4
5	Interpret rotational spectra	A	3,4
6	Analyse the theory and applications of IR spectroscopy	An	3,4
7	Determine molecular structure from IR and Raman spectra	E	2,3
8	Explain the fine structure of electronic-vibration- transitions	U	1,2
9	Understand the concepts of dissociation and pre-dissociation	U	3,5
10	Explain the concept of chemical shift and spin-spin coupling in NMR spectra	An	3,6
11	Discuss the ESR spectra and its hyperfine structure	A	5,6

PSO-Program specific outcome; CO-Course Outcome; Cognitive Level:
R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO.No
1.0	**Atomic Spectra**		
1.1	The hydrogen atom and the three quantum numbers n, l and ml.	1.5	1
1.2	Electron -spin	1	1,2
1.3	Spectroscopic terms	1	1,2
1.4	Spin-orbit interaction and derivation of spin-orbit	1.5	2

	interaction energy		
1.5	Fine structure of alkali metal spectra	1.5	3
1.6	Selection rules, Lande g factor	1.5	2
1.7	L S and j j coupling schemes (vector diagram) - examples, derivation of interaction energy	2	2
1.8	Normal, anomalous Zeeman effects and Paschen–Back effect in one electron system	2	3
1.9	Stark effect in one electron system		3
1.10	Hund's rule, Lande interval rule, Hyperfine structure and width of spectral lines(qualitative ideas only)	2	2,3
2.0	**Microwave Spectroscopy**		
2.1	Rotational spectra of diatomic molecules	2	4
2.2	Intensity of spectral lines - effect of isotopic substitution	2	4
2.3	Non–rigid rotor	2	4
2.4	Rotational spectra of polyatomic molecules	2	4,5
2.5	Linear and symmetric top molecules	2	5
2.6	Interpretation of rotational spectra	2	5
3.0	**Infra-Red and Raman Spectroscopy**		
3.1	**IR Spectroscopy**-Vibrating diatomic molecule as an harmonic oscillator,	1.5	6
3.2	Diatomic vibrating rotor – break down of Born-Oppenheimer approximation	1.5	6
3.3	Vibrations of polyatomic molecules - overtone and combination frequencies	1.5	6
3.4	Influence of rotation on the spectra of polyatomic molecules - linear and symmetric top	1.5	6.7
3.5	Analysis by IR technique, Fourier transform IR spectroscopy	1.5	7
3.6	**Raman Spectroscopy**-Pure rotational Raman spectra - linear and symmetric top molecules	1.5	7
3.7	Vibrational Raman spectra	2	7
3.8	Raman active vibrations - mutual exclusion principle -rotational fine structure - structure determination from Raman and IR spectroscopy	1.5	7
3.9	Non- linear Raman effects - hyper Raman effect - classical treatment - stimulated Raman effect	2	7
3.10	CARS, PARS - inverse Raman effect	1.5	7
4.0	**Electronic Spectroscopy of molecules**		
4.1	Electronic spectra of diatomic molecules	2	8
4.2	Progressions and sequences	2	8
4.3	Intensity of spectral lines	2	8
4.4	Franck – Condon principle	2	8
4.5	Dissociation energy and dissociation products	2	8,9

4.6	Rotational fine structure of electronic-vibrational transition	2	8,9
4.7	Fortrat parabola – Pre-dissociation	2	8,9
5.0	**Spin Resonance Spectroscopy**		
5.1	**NMR:** Quantum mechanical and classical descriptions	2	10
5.2	Relaxation processes and chemical shift	2	10
5.3	Spin–spin coupling	2	10
5.4	CW spectrometer -and applications of NMR	2	10
5.5	**ESR**: Theory of ESR	2	11
5.6	Thermal equilibrium and relaxation - g- factor	2	11
5.7	Hyperfine structure -applications	2	11

Text Books for

1. Spectroscopy, B.P. Straughan& S. Walker, Vol. 1, John Wiley & Sons
2. Fundamentals of molecular spectroscopy, C.N. Banwell, Tata McGraw Hill
3. Molecular structure and spectroscopy, G. Aruldhas, PHI Learning Pvt. Ltd.
4. Lasers and Non-Linear Optics, B.B Laud, Wiley Eastern.

ReferenceBooks:

1.Introduction of Atomic Spectra, H.E. White, McGraw Hill
2.Spectroscopy (Vol. 2 & 3), B.P. Straughan& S. Walker, Science paperbacks 1976
3. Raman Spectroscopy, D.A. Long, McGraw Hill international, 1977
4. Introduction to Molecular Spectroscopy, G.M. Barrow, McGraw Hill
5. Molecular Spectra and Molecular Structure Vol 2&3. G. Herzberg, Van Nostrand, London.
6. Elements of Spectroscopy, Gupta, Kumar & Sharma, PragathiPrakshan.

Course	Details				
Code	PH1924112				
Title	**NUCLEAR AND PARTICLE PHYSICS**				
Degree	M.Sc.				
Branch(s)	Physics				
Year/Semester	II/IV				
Type	Core				
Credits	4	**Hrs/Week**	4	**Total Hours**	72

CO No.	**Expected Course Outcomes** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Identify the various properties of nucleus	An	3
2	Discuss the nuclear forces and the theories related to it	U	2,3
3	Explain nuclear decay and nuclear reactions	An	3
4	Illustrate different nuclear models that exposes the structure of nucleus	U	2,3
5	Understand different types of nuclear reactions	U	2
6	Discuss different of nuclear reactors	Ap	3
7	Understand the concept of elementary particles and their interactions	U	3,5

PSO-Program specific outcome; CO-Course Outcome; Cognitive Level:R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO.No.
1.0	**Nuclear properties and force between nucleons**		
1.1	Nuclear radius	1	1
1.2	Mass and abundance of nuclides	1	1
1.3	Nuclear binding energy	1	1
1.4	Nuclear angular momentum and parity	1	1
1.5	Nuclear electromagnetic moments	1	1
1.6	Deuteron	2	2
1.7	Nucleon-nucleon scattering	2	2
1.8	Proton-proton scattering, neutron-neutron	3	2

	interactions		
1.9	Properties of nuclear force	2	2
1.10	Exchange forces –meson theory of nuclear force	2	2
2.0	**Nuclear decay and Nuclear reactions**		
2.1	Beta decay- energy release	1	3
2.2	Fermi theory of beta decay	1	3
2.3	Angular momentum and parity selection rules	1	3
2.4	Energy half-life relationships	1	3
2.5	Neutrino physics	1	3
2.6	Non conservation of parity	1	3
2.7	Types of reactions and conservation laws	1	3
2.8	Energetics of nuclear reactions	1	3
2.9	Isospin	1	3
2.10	Reaction cross-section	1	3
2.11	Coulomb scattering	1	3
2.12	Nuclear scattering	1	3
2.13	Scattering and reaction cross sections	1	3
2.14	Compound –nucleus reaction	1	3
2.15	Direct reactions	1	3
2.16	Heavy ion reactions	1	3
3.0	**Nuclear Models**		
3.1	Shell model potential	2	4
3.2	Spin- orbit potential	2	4
3.3	Magnetic dipole moments	1	4
3.4	Electric quadrupole moments	1	4
3.5	Valence nucleons	1	4
3.6	Collective structure	2	4
3.7	Nuclear vibrations	1	4
3.8	Nuclear rotations	1	4
3.9	Liquid drop model	1	4
3.10	Semi- empirical mass formula	2	4
4.0	**Nuclear fission and fusion**		
4.1	Characteristics of fission	1	5
4.2	Energy in fission	1	5
4.3	Fission and nuclear structure	1	5
4.4	Controlled Fission reactions	1	5

4.5	Fission reactors	1	6
4.6	Fusion processes	1	5
4.7	Characteristics of fusion	1	5
4.8	Controlled fusion reactors	1	6
5.0	**Particle Physics**		
5.1	Elementary particles and their quantum numbers (charge, spin, parity, isospin, strangeness, etc.).	2	7
5.2	Gellmann-Nishijima formula	1	7
5.3	CPT invariance	2	7
5.4	Quark model	2	7
5.5	Confined quarks	2	7
5.6	Coloured quarks, quark-gluon interaction	3	7
5.7	Application of symmetry arguments to particle reactions	1	7
5.8	Parity non-conservation in weak interaction	2	7
5.9	Quark dynamics	2	7
5.10	Grand unified theories	1	7

Text Books:

1. Kenneth S Krane, "Introductory Nuclear Physics", John Wiley & Sons, 1987.
2. D.C.Tayal, "Nuclear Physics", Himalayan Publication house, Bombay, 1980.

Reference Books:

1. R. R. Roy and B. P. Nigam, "Nuclear Physics", New Age Int. ,1983.
2. Irving Kaplan "Nuclear Physics", Narosa Book Distributors, 2002.
3. Bernard L Cohen, "Concepts of Nuclear Physics", Tata Mc Graw-Hill.,1971.
4. M. L. Pandya & R. P. S. Yadav, "Elements of Nuclear Physics", 7th Edn, (2002).
5.D.J. Griffiths, Harper & Row, Introduction to elementary particles, Wiley Eastern, 1987
6. S.N. Goshal Atomic and Nuclear Physics, S Chand & Company Ltd. 1998

Elective Courses:

1. Bunch A: Materials Science

Course	Details				
Code	PH1923301				
Title	**SCIENCE OF ADVANCED MATERIALS**				
Degree	M.Sc.				
Branch(s)	Physics				
Year/Semester	II/III				
Type	Elective				
Credits	4	**Hours/week**	4	**Total Hours**	72

CO No.	**Expected Course Outcomes** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Discuss the properties and applications of ceramics, polymers and composites	U	3,4,6
2	Explain the principles of lasing, different types of lasers and techniques of pulsed lasers	An	3.4
3	Understand the basic principles and properties of photonic crystals and its applications	U	2,3
4	Understand Electro-optic effect, magneto-optic effect, acousto-optic effect	U	3,4,6
5	Analyze the mechanism of crystal growth and different crystal growth techniques	An	3,4,6

PSO-Program specific outcome; CO-Course Outcome; Cognitive Level:
R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO.No.
1.0	**Ceramics**		
1.1	Ceramics: Types, properties and applications of ceramics:	2	1
1.2	Glass, clay, refractories, abrasives, cements	3	1

1.3	Advanced ceramics	1	1
1.4	Piezoelectric ceramics	1	1
1.5	Mechanical and glass properties	1	1
1.6	Heat treatment of glasses	1	1
1.7	Perovskite structure	1	1
1.8	Classification of ferroelectric materials	1	1
1.9	Dielectric breakdown	1	1
2.0	**Polymers and Composites**		
2.1	Polymer: Polymer Structure and Configurations	2	1
2.2	Thermosetting and thermoplastic	1	1
2.3	Copolymers, conducting polymers	2	1
2.4	Mechanical behaviour of polymers	1	1
2.5	Mechanisms of deformation and strengthening	1	1
2.6	Crystallization, melting and glass transition	2	1
2.7	Polymer types-plastics	1	1
2.8	Elastomers, fibers	1	1
2.9	Polymerisation and applications	2	1
2.10	Composite materials: particle reinforced composites,	2	1
2.11	Fiber –reinforced composites,	1	1
2.12	Structural composites,	1	1
2.13	Semimetals	1	1
3.0	**Lasers**		
3.1	Absorption of radiation	1	2
3.2	Threshold conditions	1	2
3.3	Lineshape function	1	2
3.4	Population inversion and pumping threshold conditions	2	2
3.5	Laser modes	1	2
3.6	Semiconductor lasers	1	2
3.7	Hetero-junction lasers.	1	2
3.8	Methods of pulsing lasers – Q switching	1	2
3.9	Mode locking	1	2
4.0	**Photonic materials and Applied Photonics**		
4.1	**LEDs:** Principles, structure,	2	3
4.2	**LEDs:** materials and characteristics,	1	3
4.3	heterojunction LED, SLED and ELED	2	3
4.4	**Solar cells**- principles, characteristics,	2	3
4.5	material and design considerations	2	3
4.6	PERL	2	3
4.7	heterojunction, cascaded, and schottky barrier cells,	3	3
4.8	Basic concepts and features of Photonic crystals,	2	3
4.9	Liquid crystals,	2	3
4.10	optics of metamaterials,	2	3
4.11	Amorphous semiconductors.	1	3
4.12	detector arrays-CCDs	1	3
4.13	Electro-optic effect	1	4
4.14	magneto-optic effect	1	4

4.15	acousto-optic effect	1	4
5.0	**Crystal growth**		
5.1	Mechanism of crystal growth, nucleation	2	5
5.2	Classification of crystal growth methods	1	5
5.3	Growth from melt-Czochralski	1	5
5.4	Bridgeman technique	1	5
5.5	Floatzone techniques	1	5
5.6	Growth from solution - gel growth.	1	5

Text Books:

1. Callister's Materials Science and Engineering- Wiley India
2. Optoelectronics and Photonics: Principles and Practices- S O Kasap- Pearson
3. Optoelectronics- Wilson & Hawkes- Pearson 2018;
4. Introduction to solid state physics- C Kittel- Wiley India
5. Semiconductor Physics and devices, S.S. Islam, Oxford University press

Reference books:

1. Fundamentals of Photonics- Saleh and Teich- Wiley India;
2. Lasers and Nonlinear Optics: B B Laud; New Age,
3. Solid State Physics- S O Pillai- New Age;
4. Solid State Physics- Wahab- Narosa;
5. Semiconductor Optoelectronic Devices: Pallab Bhattacharya- Pearson
6. Introduction to nanotechnology: Charles P Poole, Frank J Owens-wileyindia
7. Elementary Solid State Physics: M Ali Omar- Pearson
8. 8.Crystal growth: processes and methods- P.S. Raghavan and P. Ramasamy, KRU publications
9. Materials Science and Engineering- V Raghavan-PHI.
10. Essentials of Crystallography- M A Wahab- Narosa
11. Semiconductor Devices: Physics and Technology- S M Sze- Wiley India
12. Fiber optics and Optoelectronics- R P Khare- Oxford.

Course	Details					
Code	PH1923302					
Title	**SOLID STATE PHYSICS FOR MATERIALS**					
Degree	M.Sc.					
Branch(s)	Physics					
Year/Semester	II/ III					
Type	Elective					
Credits	3	**Hours/week**	3	**Total hours**	54	

CO No.	**Expected Course Outcomes** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Identify the various crystal dislocations and imperfections	U	6
2	Categorize Allotropy, polymorphism, polytypism, Voids, Pauling's rule and applications	An	2
3	Describe Fick's laws, its solution and applications	U	3
4	Discuss about atomic model of diffusion and other diffusion processes and mechanisms	An	1,2
5	Explain Born-Haber cycle, Madelung constant, Equilibrium lattice constants	U	2
6	Identify different crystals, its interactions and binding energies	Ap	5,6
7	Explain the microstructural changes during cooling and its applications	Ap	3
8	Classify the phase diagrams and its rule	U	4,6
9	Differentiate Plasmons, Polaritons and Polarons	Ap	2
10	Explain the excitations in solids, Magnons, excitons etc.	Ap	2

*PSO-Program Specific outcome; CO-Course Outcome;
Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
1.0	**Crystal defects**		
1.1	Crystal Imperfection- point imperfections-vacancy, Frenkel and Schottky imperfections	4	1
1.2	Dislocations- Edge, screw, Burger's vector critical resolved shear stress	4	1
1.3	Dislocation motion , dislocation reaction, dislocation energy, slip	4	1

1.4	Surface and volume imperfections – stacking faults; Fracture, twinning	2	1
1.5	Voids in close packing- size, coordination and significance	2	2
1.6	Pauling's rule and applications; Allotropy, polymorphism, polytypism	2	2
2.0	**Atomic Diffusion**		
2.1	Fick's laws, solution and applications	4	3
2.2	Kirkendall effect, Atomic model of diffusion and other diffusion processes and mechanisms	4	4
3.0	**Crystal binding**		
3.1	Crystals of inert gas	1	6
3.2	Van der Waals- London interaction, Repulsive interaction	2	6
3.3	Equilibrium lattice constants	1	5
3.4	Cohesive energy	1	6
3.5	Ionic crystals	1	6
3.6	Madelung energy, Madelung constant	2	5
3.7	Covalent crystals, metals, hydrogen bond	1	6
3.8	Born-Haber cycle	1	5
4.0	**Phase diagrams**		
4.1	Phase diagram rules	2	8
4.2	Unitary and binary phase diagrams	2	8
4.3	Microstructural changes during cooling	2	7
4.4	Applications	2	7
5.0	**Excitations in solids**		
5.1	Plasma optics, plasmons	2	9
5.2	Polaritons, LST relation	2	9
5.3	Electron-phonon interaction:polarons	2	9
5.4	KramersKronig Relations; excitons-Frenkel and Wannierexcitons, electron hole drops	2	10
5.5	Magnons- spin wave quantization and thermal excitation of magnons	2	10

Text Books:

1. Solid State Physics- Wahab- Narosa
2. Introduction to solid state physics- C Kittel- Wiley India
3. Materials Science and Engineering- V Raghavan-PHI

Reference Books:

1. Lectures on Solid State Physics- Georg Busch & Horst Schade; Pergamon Press
2. Callister's Materials Science and Engineering- Wiley India
3. Elementary Solid State Physics: M Ali Omar- Pearson
4. Solid State Physics- S O Pillai- New Age;
5. Introduction to solids- Azaroff-TMH;
6. Solid State Physics- Adrianus J Dekker- Macmillan.

Course	Details				
Code	PH1924305				
Title	**NANOSTRUCTURES AND MATERIALS CHARACTERIZATION**				
Degree	M.Sc.				
Branch(s)	Physics				
Year/Semester	II/IV				
Type	Elective				
Credits	4	**Hours/week**	4	**Total Hours**	72

CO No.	**Expected Course Outcomes** *Upon completion of this course, the students will be able to:*	Cognitive level	PSO No.
1	Understand nanomaterials, their synthesis and applications.	U	3
2	Understand the relevance of low dimensional structures by comparing their properties with bulk materials.	U	4
3	Understand the need of technological advancement for the creation of nano devices	U	3
4	Obtain a basic idea of characterization techniques to study nanomaterials in detail.	Ap	6
5	Cultivate an aptitude for research in nanomaterials.	An	6

PSO-Program specific outcome; CO-Course Outcome; Cognitive Level:
R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO .No.
1.0	**Nanostructures: An introduction**		
1.1	Applications of Schrodinger equation in nanoworld: particle confined in one dimension	2	1
1.2	Quantum leak, penetration of barrier	2	1
1.3	Nanostructures for electronics- quantum dots, nanowires	2	1
1.4	Superlattices and heterostructures	2	1
2.0	**Synthesis and properties of Nanostructures**		
2.1	Preparation of quantum nanostructures, size and dimensionality effects	2	1
2.2	Single electron tunneling	1	1
2.3	Metal nanoclusters, semiconducting nanoparticles	1	1
2.4	rare gas and molecular clusters.	2	1
2.5	Self-assembly and catalysis.	2	1
2.6	Synthesis routes: bottom up approaches- PVD	2	1
2.7	CV	2	1
2.8	MBE	2	1
2.9	PLD, wet chemical;	2	1
2.10	Top down synthesis routes- mechanical alloying	2	1

2.11	Nanolithography	2	1
3.0	**Nanomaterials and applications**		
3.1	Carbon nanostructures: carbon clusters, fullerenes	2	2
3.2	CNTs- fabrication, properties and applications	2	2
3.3	2-D nanostructure- graphene [Ref 6]	2	2
3.4	Nanostructured materials: superparamagnetic nanoparticles, GMR	2	2
3.5	ferrofluids, colossal magnetoresistance,	2	2
3.6	Nanostructured thermal devices	2	3
3.7	Superhydrophobic nanostructured surfaces, biomimetics;	2	1
3.8	Nanomachines and nanodevices- MEMs,	2	3
3.9	NEMs,nanosensors	2	3
3.10	Molecular and supramolecular switches, nanocatalysts	2	3
4.0	**X-ray diffraction methods**		
4.1	X ray diffraction- production and detection of X-rays	2	4
4.2	X-ray spectra, Moseley's law, Geometry of an X-ray diffractometer	2	4
4.3	Particle size determination, Debye Scherrer formula, stress measurement	1	4
4.4	X-ray photoelectron spectroscopy	2	4
4.5	X-ray fluorescence,	2	4
4.6	Auger recombination	2	4
4.7	Auger Emission Spectroscopy	1	4
5.0	**Electron Microscopy, Thermal methods & Methods of Electroanalytical Chemistry for Analysis**		
5.1	Working of SEM	1	4
5.2	TEM	2	4
5.3	AFM and STM with instrumentation	2	4
5.4	Mass spectrometry: ionization methods,	1	4
5.5	Mass spectrometers and analyzers, correlation of mass spectra with molecular structure.	2	4
5.6	Thermal Methods & Methods of Electroanalytical Chemistry: thermogravimetry, DTA, DTG, DSC,	2	4
5.7	Microthermal analysis; Principles of pH measurement, potentiometry, voltammetry and electrogravimetry	2	4

Text Books:

1. Introduction to nanotechnology: Charles P Poole, Frank J Owens-Wiley india
2. Textbook of nanoscience and nanotechnology- B S Murty, P Shankar, Baldev Raj, B BRath, James Muday- Springer Univ. Press
3. Introduction to nanoscience and nanotechnology- KK Chattopadhyay and A N Banerjee-PHI
4. Introduction to Nanoscience- S M Lindsay, Oxford University Press.

Reference Books:

1. Instrumental methods of analysis- Williard, Merritt, Dean, Settle- CBS
2. Introduction to nanoscience and nanotechnology- KK Chattopadhyay and A N Banerjee-PHI
3. Introduction to Nanoscience- S M Lindsay, Oxford University Press.
4. Principles of Instrumental analysis- Holler, Skoog, Crouch-Cenage

Additional References:

1. Instrumental methods of chemical analysis-Chatwal, Anand- Himalaya
2. Instrumental methods of chemical analysis- Galen W Ewing-MGH
3. X ray diffraction a practical approach: C Suryanarayana, M Grant Norton; Springer
4. Nanophotonics- Paras N Prasad: Wiley
5. Nanostructures and nanomaterials- G Cao and Y Wang- World Sci.
6. Graphene: Synthesis, Properties and Applications in Transparent electronic devices- P Kumar etal- Reviews in Advanced Sciences and Engineering, Vol 2, pp1-21, 2013.

Course	Details				
Code	PH1924306				
Title	**NANOSCIENCE AND OPTICAL SPECTROSCOPY**				
Degree	M.Sc.				
Branch(s)	Physics				
Year/Semester	II/IV				
Type	Elective				
Credits	3	**Hours/week**	3	**Total Hours**	54

CO No.	**Expected Course Outcomes** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Discuss the features and applicationsof nanomaterials	U	1,3
2	Describe the different methods of preparation of thin films	U	5,6
3	Explain the different optical properties of materials	An	2,3
4	Acquire knowledge about the use and applications of Fourier transform infrared spectroscopy	U	4,5,6
5	Understanding principles and applications of differential, difference and derivative spectroscopy	U	5,6
6	Understand the theory of absorption and emission spectroscopy	U	3,4
7	Analyze the applications of absorption and emission spectroscopy	An	5,6
8	Discuss the features and applicationsof nanomaterials	U	1,3

PSO-Program specific outcome; CO-Course Outcome; Cognitive Level:
R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO.No.
1.0	**Nano materials and Application**		
1.1	Nano structured Crystals	2	1
1.2	Natural Nano crystals	1	1
1.3	Crystals of Metal-Nano particles	1	1
1.4	Photonic Crystals	1	1
1.5	Overview of different nanomaterials available	1	1
1.6	Potential uses of nanomaterials in electronics-robotics	1	1
1.7	Computers, sensors in textile technology, sports equipment	1	1
1.8	Mobile electronic devices, vehicles and	1	1

	transportation		
1.9	Medical applications of nanomaterials	1	1
2.0	**Thin Films**		
2.1	Nature of thin films	1	2
2.2	Deposition technology-Resistance heating	2	2
2.3	Cathodic sputtering	2	2
2.4	Interferometric film thickness measurement	1	2
2.5	Applications: Antireflection coating, solar cells and sensors.	2	2
3.0	**Optical properties of materials**		
3.1	Absorption processes	1	3
3.2	photoconductivity, photovoltaic effect	1	3
3.3	Colour centers- types and generation	1	3
3.4	Luminescence	1	3
3.5	Photoluminescence	1	3
3.6	Cathodoluminescence	1	3
3.7	Electroluminescence	1	3
3.8	Radiative recombination	1	3
3.9	Gaussian Beam- Amplitude, properties, quality	1	3
3.10	Optical coherence- temporal, spatial coherence	1	3
4.0	**Optical Absorption**		
4.1	Principles of Fourier transform optical measurements	1	4
4.2	Advantages of Fourier transform spectrometry	1	4
4.3	Time domain spectrometry	1	4
4.4	Fourier transform of interferograms	1	4
4.5	Optical atomic spectra- atomic line widths, effect of temperature.	1	5
4.6	Principles and applications of differential spectroscopy	1	5
4.7	Difference and derivative spectra	1	5
4.8	Thermal lens spectroscopy	1	5
5.0	**Absorption and Emission Spectroscopy**		
5.1	Instruments for absorption photometry	1	7
5.2	Radiation sources, wavelength selection, cells and sampling devices, detectors;	1	7
5.3	Fundamental laws of photometry (Beer Lambert’s law),	1	7
5.4	Spectrophotometric accuracy, precision, absorptivity,	2	7
5.5	Bathochromic and hypsochromic shift,	1	7
5.6	Jablonski diagram.	1	7,8
5.7	General applications of uv absorption spectroscopy	1	8

5.8	Theory of fluorescence and phosphorescence spectrophotometry,	1	7
5.9	PL power, total luminescence spectroscopy,	1	7
5.10	Fluorescence lifetime measurements,	1	8
5.11	Quenching and applications,	2	8
5.12	Principle and applications of luminescence,	2	8
5.13	Qualitative ideas of resonance Raman oscopy,	2	7
5.14	Surface enhanced Raman spectroscopy	1	7

Text Books:

1. Instrumental methods of analysis- Williard, Merritt, Dean, Settle- CBS
2. Introduction to nanoscience and nanotechnology- KKChattopadhyay and A N Banerjee PHI
3. Introduction to Nanoscience- S M Lindsay, Oxford University Press.
4. Principles of Instrumental analysis- Holler, Skoog, Crouch-Cenage

Reference Books:

1. Instrumental methods of chemical analysis-Chatwal, Anand- Himalaya
2. Instrumental methods of chemical analysis- Galen W Ewing-MGH
3. Nanophotonics- Paras N Prasad: Wiley
4. Nanostructures and nanomaterials- G Cao and Y Wang- World Sci.

Course	Details				
Code	PH1924701				
Title	**MATERIAL SCIENCE PRACTICAL**				
Degree	M.Sc.				
Branch(s)	Physics				
Year/Semester	II/ IV				
Type	Core Practical				
Credits	4	**Hours/week**	10	**Total Hours**	180

CO No.	**Expected Course Outcomes** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Understand the concept of mechanical 61ehavior of materials and calculation of same using appropriate equations	U	1
2	Calculate the thermodynamic quantities, physical properties of materials.	Ap	5
3	Apply the techniques in the field of research for the identification of suitable materials.	Ap	6
4	Analyze the optical and electrical properties of materials	An	4

PSO-Program specific outcome; CO-Course Outcome; Cognitive Level:
R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C Create

(Minimum of 12 experiments should be done and recorded)

Section	Description	CO No.
1.1	Ultrasonic Interferometer – ultrasonic velocity in liquids	1
1.2	Ultrasonic Interferometer – Young's modulus and elastic constant of solids	1
1.3	Determination of dielectric constant	2
1.4	Determination of forbidden energy gap	2
1.5	Determination of Stephan's constant	2
1.6	Determination of Fermi energy of copper	2
1.7	Study of ionic conductivity in KCl / NaCl crystals	4
1.8	Thermo emf of bulk samples of metals (aluminum or copper)	4
1.9	Study of physical properties of crystals (specific heat, thermal expansion, thermal conductivity, dielectric constant)	2,3
1.10	Study of variation of dielectric constant of a ferro electric material with temperature(barium titanate)	2,3
1.11	Study of variation of magnetic properties with	2,3

	composition of a ferrite specimen	
1.12	Four probe method – energy gap	2
1.13	Energy gap of Ge or Si	2
1.14	Hall effect – Hall constant	4
1.15	Thin film coating by polymerization	3
1.16	Measurement of thickness of a thin film	3
1.17	Study of dielectric properties of a thin film	4
1.18	Study of electrical properties of a thin film(sheet resistance)	4
1.19	Growth of single crystal from solution and the determination of its structural, electrical and optical properties (NaCl, KBr, KCl,NH4Cl etc.)	3
1.20	Determination of lattice constant of a cubic crystal with accuracy and indexing the Bragg reflections in a powder X-ray photograph of a crystal	2
1.21	Observation of dislocation – etch pit method	2,3
1.22	Michelson Interferometer – Thickness of transparent film	1
1.23	X-ray diffraction – lattice constant	2
1.24	Optical absorption coefficient of thin films by filter photometry	2
1.25	Temperature measurement with sensor interfaced to a PC or a microprocessor	2
1.26	ESR spectrometer – g factor	2
1.27	Beam profile of diode laser	4
1.28	Track width of a CD using laser beam	1
1.29	He – Ne laser- verification of Malus law, measurement of Brewster angle, refractive index of a material	4

2. Bunch B: ELECTRONICS

Course	Details				
Code	PH1923303				
Title	**INTEGRATED ELECTRONICS AND DIGITAL SIGNAL PROCESSING**				
Degree	M.Sc.				
Branch(s)	Physics				
Year/Semester	II/III				
Type	Core				
Credits	4	**Hours/week**	4	**Total Hours**	72

CO No.	**Expected Course Outcomes** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1.	Illustrate the methods of fabrication of different layers in a basic monolithic IC	Ap	5,6
2.	Understand the different components of integrated circuits	U	5,6
3.	Interpret, represent and process continuous, discrete/digital signals and systems	U	2,3
4.	Analyze DSP systems like FIR and IIR Filter	An	2,3
5.	Examine different techniques of Digital Signal Processing	An	2,5
6.	Analyze the filter design techniques	An	2,5
7.	Understand the realization of filter systems	U	2,5

PSO-Program specific outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO.No.
1.0	**Integrated Circuit Fabrication and Characteristics**		
1.1	Integrated circuit technology – basic monolithic IC	3	1,2
1.2	Epitaxial growth – marking and etching	2	1,2
1.3	Diffusion of impurities	1	1
1.4	Transistor for monolithic circuit	1	1,2
1.5	Monolithic diodes	1	1,2
1.6	Integrated resistors, capacitors and inductors	3	1,2
1.7	Monolithic circuit layout	2	1,2
1.8	Additional isolation methods – MSI, LSI, VLSI (basic ideas)	2	1,2

1.9	The metal semiconductor contact.	1	1,2
2.0	**Basics of Digital Signal Processing**		
2.1	Signals,Systems and Signal Processing	1	3
2.2	Continuous time (CT) and Discrete time (DT) signals	1	3
2.3	Discrete time signals and systems	2	3
2.4	Concept of Frequency in continuous time and discrete time signals	2	3
2.5	Z-transform	2	3
2.6	Properties of Z-transform	2	3
2.7	Fourier Analysis of periodic and a periodic continuous time signal	2	3
2.8	FIR and IIR Systems	3	3,4
2.9	Frequency domain representation of systems	3	3
3.0	**DSP Techniques**		5
3.1	Frequency analysis of DT signals	2	5
3.2	Discrete Fourier Transform	2	5
3.3	Fast Fourier Transform (FFT)	2	5
3.4	Decimation in time and decimation in frequency algorithm	2	5
3.5	Z-Transform	2	5
3.6	Regional convergence and properties -	2	5
3.7	Relation to Fourier Transform	2	5
3.8	Poles and Zeroes of system function	2	5
3.9	Gibb's phenomenon	2	5
4.0	**Digital Filters- I**		
4.1	FIR and IIR Filters	1	6
4.2	IIR Filter design techniques	2	6
4.3	Approximation of derivatives	1	6
4.4	Impulse invariant method	1	6
4.5	Bilinear transformation	1	6
4.6	FIR filter design techniques	1	6
4.7	Fourier Series method	1	6
4.8	Window techniques	2	6
4.9	FIR filter using rectangular window	2	6
5.0	**Digital Filters- II**		
5.1	Realization of IIR systems	1	7
5.2	Direct form I & form II realization	2	7
5.3	Direct form and cascade form realization of FIR systems	3	7
5.4	Finite word length affecting digital signal processing	2	7

Text Books:

1. Integrated Electronics – Analog and Digital Circuits and Systems, J.Millman& C.C. Halkias,TMGH
2. Digital Signal Processing, John G. Proakis, Dimitris G. Manolakis, PHI
3. Digital Signal Processing: Theory, Analysis and Digital-Filter Design, B. Somanathan Nair, PHI (2004)
4. Digital Signal Processing, P. Ramesh Babu, Scitech
5. Digital Signal Processing, Alan V. Oppenheim & R.W. Schafer, PHI

Reference Books:

1. Computer applications in physics, Suresh Chandra, Alpha Science International (2006)
2. Digital Signal Processing, S. Salivahanan, A. Vallavaraj, C.Gnanapriya, TMH
3. Signals and Systems, Allan V. Oppenheim, Alan S. Willsky, S.H.Nawab, PHI
4. Digital signal processing, Sanjay Sharma, S.K. Kataria& Sons, 2010
5. Mathematical Methods for Physicists, G.B. Arfken& H.J. Weber.Elsevier, Academic Press.

Course	Details				
Code	PH1923304				
Title	**MICROELECTRONICS AND SEMICONDUCTORDEVICES**				
Degree	M.Sc.				
Branch(s)	Physics				
Year/Semester	II/III				
Type	Elective				
Credits	4	**Hours/week**	4	**Total Hours**	72hours

CO No.	**Expected Course Outcomes** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Acquire basic idea on 8085	U	3
2	Acquire basic idea on 8086	U	3
3	Summarise the core knowledge, architecture and applications about microcontroller.	Ap	5
4	Understand the basics of semiconductor devices	U	3,4
5	Analyze the electrostatic of the basic PN junction	An	5,6

PSO-Program specific outcome; CO-Course Outcome; Cognitive Level:
R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO.No.
1.0	**Basics of Digital Techniques**		
1.1	Review of 8085 microprocessor.	2	1
1.2	General organization of a microprocessor based microcomputer system	2	1
1.3	Memory organization – main memory array – memory management	2	1
1.4	Cache memory – virtual memory	2	1
1.5	input/output -standard I/O	2	1
1.6	Memory mapped I/O	2	1
1.7	Microcomputer I/O circuits	2	1
1.8	Interrupt driven I/O	2	1
2.0	**8086 Microprocessor**		

2.1	The Intel 8086 – architecture	2	2
2.2	MN/MX modes	2	2
2.3	8086 addressing modes	2	2
2.4	Instruction set	2	2
2.5	Instruction format	1	2
2.6	Assembler directives and operators	1	2
2.7	Programming with 8086	1	2
2.8	Interfacing memory and I/O ports	2	2
2.9	Comparison of 8086 and 8088	1	2
3.0	**Microcontroller-1**		
3.1	Introduction to microcontrollers and Embedded systems	2	3
3.2	Comparison of microprocessors and microcontrollers	2	3
3.3	The 8051 architecture	2	3
3.4	Register set of 8051- important operational features	2	3
3.5	I/O pins, ports and circuits	2	3
3.6	External memory	2	3
3.7	Counters and timers	2	3
3.8	Interrupts	2	3
4.0	**Microcontrollers-11**		
4.9	Instruction set of 8051	2	3
4.10	Basic programming concepts	2	3
4.11	Applications of microcontrollers (basic ideas)	2	3
4.12	Embedded systems(basic ideas)	2	3
5.0	**Semiconductor Devices**		
5.1	Schottky barrier diode	1	4
5.2	Qualitative characteristics	1	4
5.3	Ideal junction properties	1	4
5.4	Non ideal effects on barrier height	1	4
5.5	Current voltage relationship	1	4
5.6	Comparison with junction diode	1	4
5.7	Metal semiconductor ohmic contact	1	4
5.8	Ideal non rectifying barriers	1	4
5.9	Tunneling barrier	1	4

5.10	Specific contact resistances	2	4
5.11	Hetero-junctions	2	4
5.12	Hetero junction materials	1	4
5.13	Energy band diagram	1	4
5.14	Two dimensional electron gas	1	4
5.15	Equilibrium electrostatics	1	5
5.16	Current voltage characteristics	1	5

Text Books

1. Microprocessors and Microcomputer based system design, H.Rafiquzzaman, Universal Book stall, New Delhi
2. Microprocessor and Peripherals, S.P. Chowdhury & S. Chowdhury-SCITECH Publications
3. Microprocessor Architecture Programming and Applications with 8085,R.S. Gaonkar – Penram int. Pub. Mumbai
4. The 8051 microcontroller, Architecture Programming and Applications,Kenneth J Ayala- Penram Int. Pub. Mumbai.

Reference Books

1. Microprocessor and Peripherals, S.P. Chowdhury & S. Chowdhury-SCITECH Publications
2. Semiconductor Physics and Devices, Donald A. Neamen, McGraw Hill

Course	Details				
Code	PH1924307				
Title	**INSTRUMENTATION AND COMMUNICATION ELECTRONICS**				
Degree	M.Sc.				
Branch(s)	Physics				
Year/Semester	II/IV				
Type	ELECTIVE				
Credits	4	**Hours/week**	4	**Total Hours**	72

CO No.	**Expected Course Outcomes** *Upon completion of this course, the students will be able to:*	Cognitive Level	PSO No.
1	Discuss various types transducers, its functions and classification	U	1,6
2	Illustrate the voltage to frequency and frequency to voltage conversion	AP	2,3
3	Describe the principle and working of various digital circuits	U	4,5
4	Analyze the working basic measuring devices	An	2,3.4
5	Understand the radio wave propagation, ionospheric variations, space waves, transmission lines, characteristic impedance and losses	U	3,4
6	Evaluate the quarter and half wavelength lines	E	5
7	Understand fundamentals of television	U	3,4
8	Analyze the basic ideas of high definition TV	An	5,6
9	Summarize the core knowledge, methods and applications about the digital, data and satellite communication.	Ap	5

PSO-Program specific outcome; CO-Course Outcome; Cognitive Level:
R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO.No.
1.0	**Transducers and Digital Instrumentation**		
1.1	Classification of transducers	1	1
1.2	Strain gauges-	1	1
1.3	Piezo-electric and magnetostrictive transducers	1	1
1.4	Electrical transducer - resistive transducer	1	1

1.5	Hall effect transducers	1	1
1.6	Inductive transducer	1	1
1.7	Differential output transducers	1	1
1.8	Photoelectric transducers - photo voltaic cell	1	1
1.9	Pressure transducers - pressure cell	1	1
1.10	Thermo electric transducers	1	1
1.11	Semiconductor photo diode	1	1
1.12	Mechanical transducers	1	1
1.13	Ionization transducers.	1	1
1.14	Electro chemical transducers	2	1
2.0	**Digital Instrumentation and Recorders**		
2.1	Digital counters and timers	1	3
2.2	Digital voltmeter	1	3
2.3	RAMP,voltage to time conversion	1	2
2.4	Voltage to frequency conversion	1	2
2.5	Frequency to voltage conversion	1	2
2.6	Digital multimeter	1	3
2.7	Digital phase meter	1	3
2.8	Digital frequency meter	1	3
2.9	Tachometer	1	3
2.10	PH meter	1	3
2.11	Strip chart recorders	1	4
2.12	XY recorders, digital XY plotters	1	3
2.13	Magnetic recorders	1	3
2.14	Digital data recording - Storage oscilloscope	1	3
3.0	**Measurement of Basic Parameters**		
3.1	Transistor Voltmeter	1	4

3.2	Amplified DC meter	1	4
3.3	A.C voltmeters using rectifiers	1	4
3.4	True RMS responding voltmeter	1	4
3.5	Chopper type DC amplifier voltmeter	1	4
3.6	Milli voltmeter using operational amplifier	1	4
3.7	Differential voltmeter	1	4
3.8	Ohm meter	1	4
3.9	Stroboscope	1	4
3.10	Phase meter	1	4
3.11	Vector impedance meter	1	4
3.12	Q meter, RF measurement	1	4
4.0	**Introduction to Communication**		
4.1	Radio wave propagation	1	5
4.2	Ionosphere − Ionosphere variations	1	5
4.3	Space waves	1	5
4.4	Transmission lines	1	5
4.5	Basic principles – Characteristic impedance − Losses	1	5
4.6	Standing waves	1	5
4.7	Quarter and half wavelength lines.	1	5
4.8	Television fundamentals -Monochrome transmission	1	7
4.9	Scanning	1	7
4.10	Composite TV video wave form	1	7
4.11	Monochrome reception	1	7
4.12	Deflection circuits	1	7
4.13	Colour Television	1	7
4.14	Basic ideas of high definition TV	1	8
4.15	LCD TV	1	8
4.16	LED TV	1	8
5.0	**Digital Communication**		
5.1	Pulse Communication	1	9
5.2	Information theory	1	9
5.3	Coding – Noise – Pulse modulation	1	9
5.4	PAM – PTM – PCM – PPM	1	9
5.5	Digital communication	1	9

5.6	Data Communication Digital codes	1	9
5.7	Data Sets and interconnection requirements.	1	9
5.8	Multiplexing techniques	1	9
5.9	Frequency division and time division multiplexing	1	9
5.10	Microwave generators	1	9
5.11	Klystron and Magnetron	1	9
5.12	Satellite communication	1	9
5.13	Digital cellular systems GSM	1	9
5.14	TDMA and CDMA	1	9
5.15	Basic ideas of GPS	1	9

Text Books:

1. Electronic Instrumentation, H.S. Kalsi, TMH (1995)
2. Transducers and instrumentation, D.V.S. Murty, PHI (1995)
3. Monochrome and Colour Television R.R. Gulati, New Age India
4. Electronic communication systems, George Kennedy, TMH
5. Mobile Cellular Telecommunication Systems, William C.Y. Lee, MGH

Reference Books:

1. Modern electronic Instrumentation and Measurement Techniques, A.D. Helfric& W.D. Cooper, PHI, (1997)
2. Instrumentation-Devices and Systems 2ndEdn. C.S. Rangan, G.R. Sarma, V.S.V. Mani, TMH, (1998)
3. Electronic Measurements and Instrumentation, M.B. Olive &J.M.Cage, MGH, (1975)
4. Digital Instrumentation, A.J. Bouwens,TMH, (1998)
5. Elements of Electronic Instrumentation, J. Jha, M. Puri, K.R. Sukesh,&M.Kovar., Narosa, (1996)
6. Instrumentation Measurement and Analysis, B.C. Nakra&K.K.Chaudhry, TMH, (1998)
7. Op-amps and Linear Integrated Circuits, R.A. Gaykward, PHI, (1989)
8. Electronic fundamentals and Applications, John D. Ryder, PHI.
9. Satellite communication, Robert M.Gagliardi, CBS Publishers, Delhi.
10. Electric and electronic measurements and instrumentation 10th Edn. A.K. Sawhney, DhanpathRai& Company.

Course	Details				
Code	PH1924308				
Title	**OPTOELECTRONICS**				
Degree	M.Sc.				
Branch(s)	Physics				
Year/Semester	II/IV				
Type	Core				
Credits	3	**Hours/week**	3	**Total Hours**	54

CO No.	**Expected Course Outcomes** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Analyse the theories of Semiconductors and LEDs	An	1,3
2	Discuss the basic principle and working of Optical Fiber	U	1,4
3	Describe the Characteristics of optical waveguide	U	1,4
4	Explain different optical devices and its working	U	1,3
5	Describe the physical construction, working and operation of semiconductor devices	U	1,3
6	Solve problems related tosemiconductor, Fiber optics and nonlinear optics	Ap	1, 2
7	Apply theories on NLO for practical applications	Ap	5

PSO-Program specific outcome; CO-Course Outcome; Cognitive Level:
R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO.No.
1.0	**Semiconductor Science and Light Emitting Diodes**		
1.1	Semiconductor energy bands - semiconductor statistics emitting LEDs.	1	1,7
1.2	Extrinsic semiconductors – compensation doping – degenerate and non-degenerate semiconductors	1	1,7
1.3	Energy band diagrams in applied field - direct and indirect bandgap semiconductors	1	1,7
1.4	P-n junction principles - open circuit- forward and reverse bias – recombination life-time	1	1,7
1.5	Light emitting diodes – principles - device structures,	2	1,7
1.6	Hetero junction high intensity LEDs – double heterostructure	1	1,7

1.7	LED characteristics and LEDs for optical fibre communications - surface and edge	1	1,7
2.0	**Fibre Optics**		
2.1	Symmetric planar dielectric slab waveguide – waveguide condition	1	2,7
2.2	single and multimode waveguides TE and TM modes	1	2,7
2.3	Modal and waveguide dispersion in the planar waveguide	1	2,7
2.4	Dispersion diagram – intermodal dispersion – intramodal dispersion – dispersion in single mode fibers	2	2,7
2.5	Material dispersion – waveguide dispersion – chromatic dispersion	1	2,7
2.6	Profile and polarization dispersion – dispersion flattened fibers - bit rate and dispersion	2	2,7
2.7	Optical and electrical bandwidth – graded index optical fiber	1	2,7
2.8	Light absorption and scattering – attenuation in optical fibers	1	2,7
3.0	Optical Devices (18 hrs)		
3.1	Principle of p-n junction photodiode - Ramo’s theorem and external photocurrent	2	4,5
3.2	absorption coefficient and photodiode materials - quantum efficiency and responsivity	3	4,5
3.3	PIN-photodiode – avalanche photodiode – phototransistor	2	4,5
3.4	Photoconductive detectors and photoconductive gain - noise in photo-detectors – noise in avalanche photodiode	3	4,5
3.5	Solar energy spectrum - photovoltaic device principles – I-V characteristics -	3	4,5
3.6	Series resistance and equivalent circuit - temperature effects	2	4,5
3.7	Solar cell materials, device and efficiencies	3	4,5
4.0	**Optoelectronic Modulators**		
4.1	Optical polarization	1	5,6
4.2	Birefringence	1	5,6
4.3	Retardation plates	1	5,6
4.4	Electro-optic Modulators, Pockels effect	2	5,6
4.5	Kerr effect	1	5,6
4.6	Magneto-optic effect	2	5,6
4.7	Acousto-optic effect	1	5,6
4.8	Raman Nath and Bragg-types	1	5,6
5.0	**Non-linear optics**		
5.1	Wave propagation in an anisotropic crystal -	2	7

	polarization response of materials to light		
5.2	Second order non-linear optical processes - second harmonic generation	1	7
5.3	Sum and frequency generation, optical parametric oscillation	1	7
5.4	Third order non-linear optical processes - third harmonic generation	1	7
5.5	Intensity dependent refractive index - self-focusing	1	7
5.6	Non-linear optical materials, phase matching - angle tuning	1	7
5.7	Saturable absorption - two photon absorption.	1	7

Text Books

1. Optoelectronics and Photonics: Principles and Practices, S.O. Kasap
2. Fiber optics and Optoelectronics, R.P. Khare, Oxford University Press, (2004)
3. Optoelectronics: an Introduction, J. Wilson and J.F.B. Hawkes,PHI, (2000)
4. Laser fundamentals, William T. Silfvast, CUP 2nd Edn. (2009),

Reference Books

1. Semiconductor optoelectronic devices: Pallab Bhattacharya, Pearson (2008)
2. Optoelectronics: An introduction to materials and devices, JaspritSingh,McGraw Hill International Edn., (1996).
3. Optical waves in crystals: Propagation and Control of Laser Radiation, A.Yariv and P. Yeh, John Wiley and Sons Pub. (2003).

Course	Details				
Code	PH1924702				
Title	**ADVANCED ELECTRONICS PRACTICAL**				
Degree	M.Sc.				
Branch(s)	Physics				
Year/Semester	II/ IV				
Type	Core Practical				
Credits	4	**Hours/week**	10	**Total Hours**	180

CO No.	**Expected Course Outcomes** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Apply using Microprocessors and Micro-controllers various circuits	Ap	1,4,5
2	Analyse the generation of PAM and PWM using electronic circuits	An	1,4,5
3	Construct the important electronic instrumentation works	Ap	1,4,5
4	. Determine the relevant parameters in optoelectronics	E	1,5

PSO-Program specific outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

(Minimum of 12 experiments should be done choosing at least 2 experiments from each group)

Section	Description	CO.No.
	[A] Microprocessors and Micro-controllers (use a PC or 8086-µp kit)	
1.1	Sorting of numbers in ascending/descending order.	1
1.2	Find the largest and smallest of numbers in array of memory.	1
1.3	Conversion of Hexadecimal number to ASCII and ASCII to Hexadecimal number	1
1.4	Multichannel analog voltage measurements using AC card.	1
1.5	Generation of square wave of different periods using a microcontroller.	1
1.6	Measurement of frequency, current and voltage using microprocessors	1
	[B] Communication Electronics	
1.7	Generation of PAM and PWM	2
1.8	8. Frequency modulation and demodulation using IC –CD4046.	2
1.9	9. Multiplexer and demultiplexer using digital IC	2

	7432.	
1.10	10. Radiation characteristics of a horn antenna.	2
1.11	11. Measurement of characteristic impedance and transmission line parameters of a coaxial cable.	2
	[C] Electronic Instrumentation	
1.12	DC and AC milli-voltmeter construction and calibration.	3
1.13	Amplified DC voltmeter using FET.	3
1.14	Instrumentation amplifier using a transducer.	3
1.15	Generation of BH curve and diode characteristics on CRO.	3
1.16	Voltage to frequency and frequency to voltage conversion.	3
1.17	Construction of digital frequency meter.	3
1.18	Characterization of PLL and frequency multiplier and FM detector	3
	[D] Optoelectronics	4
1.19	Characteristic of a photo diode - Determination of the relevant parameters.	4
1.20	Beam Profile of laser, spot size and divergence.	4
1.21	Temperature co-efficient of resistance of copper.	4
1.22	Data transmission and reception through optical fiber link.	4

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