MAR ATHANASIUS COLLEGE (AUTONOMOUS)

KOTHAMANGALAM, KERALA 686 666

NAAC Accredited ‘A^{+}’ Grade Institution

Email: mac@macollege.in

www.macollege.in

SCHEME AND SYLLABUS

FOR

POST GRADUATE PROGRAMME

UNDER CREDIT SEMESTER SYSTEM

MAC-PG-CSS 2020

IN

M.Sc. PHYSICS

EFFECTIVE FROM THE ACADEMIC YEAR 2020-2021

BOARD OF STUDIES IN PHYSICS (PG)

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ACADEMIC COUNCIL

COMPOSITION – With Effect From 01-06-2020

Chairperson : **Dr. Shanti. A. Avirah**
Principal
Mar Athanasius College (Autonomous), Kothamangalam

Experts/Academicians from outside the college representing such areas as Industry, Commerce, Law, Education, Medicine, Engineering, Sciences etc.

1. **Dr. Winny Varghese**
Secretary
Mar Athanasius College Association
Kothamangalam

2. **Prof. Dr. V.N. Rajasekharan Pillai**
Former Vice-Chairman
University Grants Commission,
New Delhi.

3. **Dr. R.K. Chauhan**
Former Vice-Chancellor, Lingaya's University,
Faridabad, Haryana -121002

4. **Dr. Sheela Ramachandran**
Pro-Chancellor,
Atmiya University
Rajkot.

5. **Prof. Kuruvilla Joseph**
Senior Professor and Dean,
Indian Institute of Space Science and Technology (IIST),
Department of Space, Govt. of India, Valiyamala, Thiruvananthapuram.

6. **Dr. M.C. Dileep Kumar**
Former Vice Chancellor
SreeSankaracharya Sanskrit University
Kalady, Kerala, India.

7. **Dr. Mathew. K.**
Principal
Mar Athanasius College of Engineering,
Kothamangalam, Kerala - 686 666

8. **Adv. George Jacob**
Senior Advocate
High Court of Kerala
Ernakulam.

Nominees of the university not less than Professors

9. **Dr. Biju Pushpan**
   SAS SNDP Yogam College
   Konni.

10. **Dr. Suma Mary Scharia**
    UC College
    Aluva.

11. **Dr. V.B. Nishi**
    Associate Professor
    Sree Sankara College, Kalady.

Member Secretary

12. **Dr. M.S.Vijayakumary**
    Dean – Academics
    Mar Athanasius College (Autonomous)
    Kothamangalam.

Four teachers of the college representing different categories of teaching staff by rotation on the basis of seniority of service in the college.

13. **Dr. Bino Sebastian. V** (Controller of Examinations)
14. **Dr. Manju Kurian,** Asst. Professor, Department of Chemistry
15. **Dr. Smitha Thankachan**, Asst. Professor, Department of Physics
16. **Dr. Asha Mathai**, Asst. Professor, Department of Malayalam

Heads of the Departments

17. Dr. Jayamma Francis, Head, Department of Chemistry
18. Dr. Mini Varghese, Head, Department of Hindi
19. Ms. Shiny John, Head, Department of Computer Science
20. Dr. Igy George, Head, Department of Economics
21. Dr. Rajesh.K. Thumbakara, Head, Department of Mathematics
22. Dr. Aji Abraham, Head, Department of Botany
23. Dr. Selven S., Head, Department of Zoology
24. Dr. Deepa. S, Head, Department of Physics
25. Dr. Aswathy Balachandran, Head, Department of English

26. Dr. Diana Ann Issac, Head, Department of Commerce
27. Ms. Seena John, Head, Department of Malayalam
28. Ms. Diana Mathews, Head, Department of Sociology
29. Ms. Sudha. V, Head, Department of Statistics
30. Dr. Jani Chungath, Head, Department of History
31. Sri. Haary Benny Chettiamkudiyil, Head, Department of Physical Education
32. Ms. Shari Sadasivan, Head, Department of Marketing and International Business
33. Dr. Julie Jacob, Head, Department of Biochemistry
34. Ms. Nivya Mariyam Paul, Head, Department of Microbiology
35. Ms. Jaya Vinny Eappen, Head, Department of Biotechnology
36. Ms. Shalini Binu, Head, Department of Actuarial Science
37. Ms. Simi. C.V, Head, Post Graduate Department of History
38. Ms. Sari Thomas, Head, Post Graduate Department of Statistics
39. Ms. Sheeba Stephen, Head, Department of B.Com Model III - Tax Procedure and Practice
40. Ms. Dilmol Varghese, Head, Post Graduate Department of Zoology
41. Ms. Bibin Paul, Head, Post Graduate Department of Sociology

BOARD OF STUDIES IN PHYSICS (PG)

Sl No	Name	Official Address
1	Chairman	**Dr. Deepa S.** Assistant Professor of Physics (HOD) Mar Athanasius College Kothamangalam
2	Members	**Dr. S. Sankara Raman** Associate Professor Department of Opto-Electronics Kerala University
3		**Dr. Sajimol Augustine M.** Principal St: Teresa’s College Ernakulam
4		**Dr. Sajan D.** Assistant Professor Bishop Moore College Mavelikara
5		**Dr. C. Vijayan** Professor Department of Physics IIT Madras
6		**Mr. Jolly Cyriac** Managing Director Holmark Opto-Mechatronics Pvt. Ltd H M T Industrial Estate Kalamassery
7		**Dr. Benoy M.D.** Associate Professor of Physics M A College , Kothamangalam

8	Members	**Dr. Smitha Thankachan** Assistant Professor of Physics M A College , Kothamangalam
9		**Mr. Francis Xavier P.A.** Assistant Professor of Physics M A College , Kothamangalam
10		**Ms. Jassi J.** Assistant Professor of Physics M A College , Kothamangalam
11		**Dr. Saritha K. Nair** Assistant Professor of Physics M A College , Kothamangalam

TABLE OF CONTENTS

PREFACE

The P.G. syllabus in Physics of Mar Athanasius College (Autonomous), Kothamangalam is restructured to suit the credit and semester system to be followed by the affiliated colleges under Mahatma Gandhi (M.G.) University, Kottayam, from the academic year 2020-2021. Now as the continuation of the credit and semester system being followed in the U.G. courses in the college, we have restructured the P.G. curriculum. In the restructuring of the P.G. syllabus, the Board of Studies has taken into account the emerging trends in the various fields of theoretical and experimental physics. The focus was given to set high standards of comprehensive education by developing the intellectual strength of students and guiding them towards scientific and technical excellence in compatible with the vision and mission of our institution. There was special emphasis on building the foundation for excellence and spur development of the institution as a premier institution by igniting and nurturing enthusiasm, interests and passion, in the study of Physics, as a part of curricula with the objective of sustainable development of economy and society as a whole. Wide discussion in this matter was carried out among the physics teaching faculty as well as the other dignitaries in the Board of Studies. In order to accommodate various front running fields in physics, and for the students to have option to select the courses of their interest, the Board has decided to present four Elective Bunch with three courses each in the P.G. syllabus. The elective courses are accommodated in the third and fourth semesters of the P G program. The syllabus of physics practicals is also revised keeping in view of the advances in various fields of physics and technology. Each semester will have one practical each with two practical exams at the end of even semesters.

Dr. Deepa.S, Chairman, PG Board of Studies in Physics

LIST OF POST GRADUATE PROGRAMMES IN MAR ATHANASIUS COLLEGE (AUTONOMOUS), KOTHAMANGALAM

SL. NO.	PROGRAMME	DEGREE	FACULTY
1	ENGLISH	MA	LANGUAGE AND LITERATURE
2	ECONOMICS	MA	SOCIAL SCIENCES
3	SOCIOLOGY	MA	SOCIAL SCIENCES
4	HISTORY	MA	SOCIAL SCIENCES
5	MATHEMATICS	M.Sc	SCIENCE
6	CHEMISTRY	M.Sc	SCIENCE
7	PHYSICS	M.Sc	SCIENCE
8	BOTANY	M.Sc	SCIENCE
9	STATISTICS	M.Sc	SCIENCE
10	ZOOLOGY	M.Sc	SCIENCE
11	BIOCHEMISTRY	M.Sc	SCIENCE
12	BIOTECHNOLOGY	M.Sc	SCIENCE
13	MICROBIOLOGY	M.Sc	SCIENCE
14	ACTUARIAL SCIENCE	M.Sc	SCIENCE
15	COMMERCE(SPECIALISATION-FINANCE AND TAXATION)	M.Com	COMMERCE
16	COMMERCE(SPECIALISATION-MARKETING AND INTERNATIONAL BUSINESS	M.Com	COMMERCE

REGULATIONS OF THE POSTGRADUATE PROGRAMMES
UNDER CREDIT SEMESTER SYSTEM
MAC-PG-CSS 2020
(2020 Admission onwards)

1. SHORT TITLE

1.1 These Regulations shall be called "Mar Athanasius College (Autonomous) Regulations (2020) governing Postgraduate Programmes under the Credit Semester System (MAC-PG-CSS2020)".

1.2 These Regulations shall come into force from the Academic Year 2020-2021.

2. SCOPE

2.1 The regulations provided herein shall apply to all Regular Postgraduate (PG) Programmes, M.A. /M.Sc. /M.Com. conducted by Mar Athanasius College (Autonomous) with effect from the academic year 2020-2021 admission onwards.

3. DEFINITIONS

3.1 **'Academic Committee'** means the Committee constituted by the Principal under this regulation to monitor the running of the Post-Graduate programmes under the Credit Semester System (MAC-PG-CSS2020).

3.2 **'Academic Week'** is a unit of five working days in which distribution of work is organized from day one to day five, with five contact hours of one hour duration on each day. A sequence of 18 such academic weeks constitutes a semester.

3.3 '**Audit Course**' is a course for which no credits are awarded.

3.4 **‘CE’ means Continuous Evaluation (Internal Evaluation)**

3.5 **‘College Co-ordinator’** means a teacher from the college nominated by the Principal to look into the matters relating to MAC-PG-CSS2020 for programmes conducted in the College.

3.6 **‘Comprehensive Viva-Voce’** means the oral examinations conducted by the appointed examiners and shall cover all courses of study undergone by a student for the programme.

3.7 **‘Common Course’** is a core course which is included in more than one programme with the same course code.

3.8 ‘**Core Course**’ means a course that the student admitted to a particular programme must successfully complete to receive the Degree and which cannot be substituted by any other course.

3.9 ‘**Course**’ means a segment of subject matter to be covered in a semester. Each Course is to be designed variously under lectures / tutorials / laboratory or fieldwork / seminar / project /practical training / assignments/evaluation etc., to meet effective teaching and learning needs.

3.10 **‘Course Code’** means a unique alpha numeric code assigned to each course of a programme.

3.11 ‘**Course Credit**’ One credit of the course is defined as a minimum of one hour lecture /minimum of 2 hours lab/field work per week for 18 weeks in a Semester. The course will be considered as completed only by conducting the final examination.

3.12 **‘Course Teacher’** means the teacher of the institution in charge of the course offered in the programme.

3.13 **‘Credit (Cr)’** of a course is a numerical value which depicts the measure of the weekly unit of work assigned for that course in a semester.

3.14 ‘**Credit Point(CP)**’ of a course is the value obtained by multiplying the grade point (GP) by the Credit (Cr) of the course **CP=GP x Cr**.

3.15 ‘**Cumulative Grade Point Average(CGPA)**’ is the value obtained by dividing the sum of credit points in all the courses taken by the student for the entire programme by the total number of credits and shall be rounded off to two decimal places. CGPA determines the overall performance of a student at the end of a programme.

(CGPA = Total CP obtained/ Total credits of the programme)

3.16 '**Department**' means any teaching Department offering a programme of study in the institution.

3.17 '**Department Council**' means the body of all teachers of a Department in a College.

3.18 **'Dissertation'** means a long document on a particular subject in connection with the project /research/ field work etc.

3.19 '**Duration of Programme**' means the period of time required for the conduct of the programme. The duration of post-graduate programme shall be 4 semesters spread over two academic years.

3.20 '**Elective Course**' means a course, which can be substituted, by equivalent course from the same subject.

3.21 **'Elective Group'** means a group consisting of elective courses for the programme.

3.22 **'ESE' means End Semester Evaluation (External Evaluation).**

3.23 **'Evaluation'** is the process by which the knowledge acquired by the student is quantified as per the criteria detailed in these regulations.

3.24 **External Examiner** is the teacher appointed from other colleges for the valuation of courses of study undergone by the student in a college. The external examiner shall be appointed by the college.

3.25 '**Faculty Advisor**' is a teacher nominated by a Department Council to coordinate the continuous evaluation and other academic activities undertaken in the Department.

3.26 '**Grace Grade Points**' means grade points awarded to course(s), recognition of the students' meritorious achievements in NSS/ Sports/ Arts and cultural activities etc.

3.27 '**Grade Point**' (GP) Each letter grade is assigned a Grade point (GP) which is an integer indicating the numerical equivalent of the broad level of performance of a student in a course.

3.28 '**Grade Point Average(GPA)**' is an index of the performance of a student in a course. It is obtained by dividing the sum of the weighted grade point obtained in the course by the sum of the weights of Course.**(GPA= ∑WGP / ∑W)**

3.29 '**Improvement Course**' is a course registered by a student for improving his performance in that particular course.

3.30 **'Internal Examiner'** is a teacher nominated by the department concerned to conduct internal evaluation.

3.31 '**Letter Grade**' or '**Grade**' for a course is a letter symbol (A+, A, B+, B, C+, C, D) which indicates the broad level of performance of a student for a course.

3.32 MAC-PG-CSS2020 means Mar Athanasius College Regulations Governing Post Graduate programmes under Credit Semester System, 2020.

3.33 '**Parent Department**' means the Department which offers a particular postgraduate programme.

3.34 '**Plagiarism**' is the unreferenced use of other authors' material in dissertations and is a serious academic offence.

3.35 '**Programme**' means the entire course of study and Examinations.

3.36 **'Project'** is a core course in a programme. It means a regular project work with stated credits on which the student undergo a project under the supervision of a teacher in the parent department/ any appropriate research centre in order to submit a dissertation on the project work as specified. It allows students to work more autonomously to construct their own learning and culminates in realistic, student-generated products or findings.

3.37 '**Repeat Course**' is a course to complete the programme in an earlier registration.

3.38 '**Semester**' means a term consisting of a minimum of 90 working days, inclusive of examination, distributed over a minimum of 18 weeks of 5 working days each.

3.39 '**Seminar**' means a lecture given by the student on a selected topic and expected to train the student in self-study, collection of relevant matter from various resources, editing, document writing and presentation.

3.40 '**Semester Grade Point Average(SGPA)**' is the value obtained by dividing the sum of credit points (CP) obtained by the student in the various courses taken in a semester by the total number of credits for the course in that semester. The SGPA shall be rounded off to two decimal places. SGPA determines the overall performance of a student at the end of a semester (SGPA = Total CP obtained in the semester / Total Credits for the semester).

3.41 '**Tutorial**' means a class to provide an opportunity to interact with students at their individual level to identify the strength and weakness of individual students.

3.42 '**Weight**' is a numeric measure assigned to the assessment units of various components of a course of study.

3.43 **University** means Mahatma Gandhi University Kottayam to which the college is affiliated.

3.44 '**Weighted Grade Point (WGP)**' is grade points multiplied by weight. **(WGP=GPxW)**

3.45 **'Weighted Grade Point Average (WGPA)' is an index of the performance of a student in a course. It is obtained by dividing the sum of the weighted grade points by the sum of the weights. WGPA shall be obtained for CE (Continuous Evaluation) and ESE (End Semester Evaluation) separately and then the combined WGPA shall be obtained for each course.**

4. ACADEMIC COMMITTEE

4.1. There shall be an Academic Committee constituted by the Principal to Manage and monitor the working of MAC-PG-CSS2020.

4.2. The Committee consists of:

1. Principal
2. Dean, Administration
3. Dean, Academics
4. IQAC Coordinator
5. Controller of Examinations
6. One Faculty each representing Arts, Science, Commerce, Languages, and Self Financing Programmes

5. PROGRAMME STRUCTURE

5.1 Students shall be admitted to post graduate programme under thevarious Faculties. The programme shall include three types of courses, Core Courses, Elective Courses and Common core courses. There shall be a project with dissertation and comprehensive viva-voce as core courses for all programmes. The programme shall also include assignments / seminars/ practical's etc.

5.2 No regular student shall register for more than 25 credits and less than16 credits per semester unless otherwise specified. The total minimum credits, required for completing a PG programme is 80.

5.3. Elective Courses and Groups

5.3.1 There shall be various groups of Programme Elective courses for a Programme such as Group A, Group B etc. for the choice of students subject to the availability of facility and infrastructure in the institution and the selected group shall be the subject of specialization of the programme.

5.3.2 The elective courses shall be either in fourth semester or distributed among third and fourth semesters. There may be various groups of Elective courses (three elective courses in each group) for a programme such as Group

A, Group B etc. for the choice of students, subject to the availability of facility and infrastructure in the institution.

5.3.3 The selection of courses from different elective groups is not permitted.

5.3.4 The elective groups selected for the various Programmes shall be intimated to the Controller of Examinations within two weeks of commencement of the semester in which the elective courses are offered. The elective group selected for the students who are admitted in a particular academic year for various programmes shall not be changed.

5.4 Project Work

5.4.1. Project work shall be completed in accordance with the guidelines given in the curriculum.

5.4.2 Project work shall be carried out under the supervision of a teacher of the department concerned.

5.4.3. A candidate may, however, in certain cases be permitted to work on the project in an Industrial/Research Organization on the recommendation of the supervising teacher.

5.4.4 There shall be an internal assessment and external assessment for the project work.

5.4.5. The Project work shall be evaluated based on the presentation of the project work done by the student, the dissertation submitted and the viva-voce on the project.

5.4.6 The external evaluation of project work shall be conducted by two external examiners from different colleges and an internal examiner from the college concerned.

5.4.7 The final Grade of the project (External) shall be calculated by taking the average of the Weighted Grade Points given by the two external examiners and the internal examiner.

5.5 **Assignments:** Every student shall submit at least one assignment as an internal component for each course.

5.6 **Seminar Lecture:** Every PG student shall deliver one seminar lecture as an

Internal component for every course with a weightage of two. The seminar lecture is expected to train the student in self-study, collection of relevant matter from the various resources, editing, document writing and presentation.

5.7 **Test Papers(Internal):**Every PG student shall undergo at least two class tests as an internal component for every course with a weight one each. The best two shall be taken for awarding the grade for class tests.

5.8. **No courses shall have more than 5 credits unless otherwise specified.**

5.9. **Comprehensive Viva-Voce** -Comprehensive Viva-Voce shall be conducted at the end of fourth semester of the programme and its evaluation shall be conducted by the examiners of the project evaluation.

5.9.1. Comprehensive Viva-Voce shall cover questions from all courses in the Programme.

5.9.2. There shall be an internal assessment and an external assessment for the Comprehensive Viva-Voce.

6. ATTENDANCE

6.1. The minimum requirement of aggregate attendance during a semester for appearing at the end-semester examination shall be 75%. Condonation of shortage of attendance to a maximum of 15 days in a semester subject to a maximum of two times during the whole period of the programme may be granted by the University.

6.2 If a student represents his/her institution, University, State or Nation in Sports, NCC, or Cultural or any other officially sponsored activities such as college union/ university union etc., he/she shall be eligible to claim the attendance for the actual number of days participated subject to a maximum 15 days in a Semester based on the specific recommendations of the Head of the Department or teacher concerned.

6.3 Those who could not register for the examination of a particular semester due to shortage of attendance may repeat the semester along with junior batches, without considering sanctioned strength, subject to the existing University Rules and Clause 7.2.

6.4. A Regular student who has undergone a programme of study under earlier regulation/ Scheme and could not complete the Programme due to shortage of attendance may repeat the semester along with the regular batch subject to the condition that he has to undergo all the examinations of the previous semesters as per the MAC-PG-CSS 2020 regulations and conditions specified in 6.3.

6.5 A student who had sufficient attendance and could not register for fourth semester examination can appear for the end semester examination in the subsequent years with the attendance and progress report from the principal.

7. REGISTRATION/ DURATION

7.1 A student shall be permitted to register for the programme at the time of admission.

7.2 A student who registered for the Programme shall complete the Programme within a period of four years from the date of commencement of the programme.

7.3 Students are eligible to pursue studies for additional post graduate degree. They shall be eligible for award of degree only after successful completion of two years (four semesters of study) of college going.

8. ADMISSION

8.1 The admission to all PG programmes shall be done through the Centralised Allotment Process of Mar Athanasius College (Autonomous), Kothamangalam (MAC-PG CAP) as per the rules and regulations prescribed by the affiliating university and the Government of Kerala from time to time.

8.2 The eligibility criteria for admission shall be as announced by the Parent University from time to time.

9. ADMISSION REQUIREMENTS

9.1 Candidates for admission to the first semester of the PG programme through CSS shall be required to have passed an appropriate Degree Examination of Mahatma Gandhi University as specified or any other examination of any recognized University or authority accepted by the Academic council of Mahatma Gandhi University as eligible thereto.

9.2 Students admitted under this programme are governed by the Regulations in force.

10. PROMOTION:

10.1 A student who registers for the end semester examination shall be promoted to the next semester.

10.2 A student having 75% attendance and who fails to register for examination of a particular semester will be allowed to register notionally and is promoted to the next semester, provided application for notional registration shall be submitted within 15 days from the commencement of the next semester.

10.3 The medium of Instruction shall be English except programmes under faculty of Language and Literature.

11. EXAMINATIONS

11.1 **End-Semester Examinations**: The examinations shall be at the end of each Semester of three hour duration for each centralised and practical course.

11.2 Practical examinations shall be conducted at the end of each semester or at the end of even semesters as prescribed in the syllabus of the particular programme. The number of examiners for the practical examinations shall be prescribed by the Board of Studies of the programmes.

11.3 A question paper may contain short answer type/annotation, short essay type questions/problems and long essay type questions. Different types of questions shall have different weightage.

12. EVALUATION AND GRADING

12.1 **Evaluation:** The evaluation scheme for each course shall contain two parts; (a) End Semester Evaluation(ESE) (External Evaluation) and (b) Continuous Evaluation(CE)(Internal Evaluation). 25% weightage shall be given to internal evaluation and the remaining 75% to external evaluation and the ratio and weightage between internal and external is 1:3. Both End Semester Evaluation(ESE) and Continuous Evaluation(CE) shall be carried out using direct grading system.

12.2 **Direct Grading: The direct grading for CE (Internal) and ESE(External Evaluation) shall be based on 6 letter grades (A+, A, B, C, D and E) with numerical values of 5, 4, 3, 2, 1 and 0 respectively.**

12.3 **Grade Point Average (GPA):Internal and External components are separately graded and the combined grade point with weightage 1 for internal and 3 for external shall be applied to calculate the Grade Point Average (GPA) of each course. Letter grade shall be assigned to each course based on the categorization provided in 12.16.**

12.4 **Internal evaluation:** The internal evaluation shall be based on predetermined transparent system periodic written tests, assignments, seminars, lab skills, records, viva-voce etc.

12.5 Components of internal (CE) and External Evaluation (ESE): Grades shall be given to the evaluation of theory / practical / project / comprehensive viva-voce and all internal evaluations are based on the Direct Grading System.

Proper guidelines shall be prepared by the BOS for evaluating the assignment, seminar, practical, project and comprehensive viva-voce within the framework of the regulation.

12.6 There shall be no separate minimum grade point for internal evaluation.

12.7 **The model of the components and its weightages for Continuous Evaluation (CE) and End Semester Evaluation (ESE) are shown in below:**

a) For Theory (CE) (Internal)

	Components	Weightage
i.	Assignment	1
ii.	Seminar	2
iii.	Best Two Test papers	2(1 each)
Total		**5**

(Average grade of the best two papers can be considered. For test paper all the Questions shall be set in such a way that the answers can be awarded A+, A, B, C, D, E grades)

b) For Theory (ESE) (External)

Evaluation is based on the pattern of Question specified **in 12.15.5**

c) For Practical (CE) (Internal)

Components	Weightage
Written / Lab Test	2
Lab Involvement and Record	1
Viva	2
Total	**5**

(The components and weightage of the practical(Internal) can be modified by the concerned BOS without changing the total weightage 5)

d) For Practical (ESE) (External)

Components	Weightage
Written / Lab Test	7
Lab Involvement and Record	3
Viva	5
Total	**15**

(The components and weightage of the practical (External) can be modified by the concerned BOS without changing the total weightage 15)

e) For Project (CE) (Internal)

Components	Weightage
Relevance of the topic and analysis	2
Project content and presentation	2
Project viva	1
Total	**5**

(The components and the weightage of the components of the Project (Internal) can be modified by the concerned BOS without changing the total weightage 5)

f) For Project(ESE) (External)

Components	Weightage
Relevance of the topic and analysis	3
Project content and presentation	7
Project viva	5
Total	**15**

(The components and the weightage of the components of the Project (External) can be modified by the concerned BOS without changing the total weightage 15)

g) Comprehensive viva-voce (CE) (Internal)

Components	Weightage
Comprehensive viva-voce(all courses from first semester to fourth semester)	5
Total	**5**

(Weightage of the components of the Comprehensive viva-voce(Internal) shall not be modified.)

h)Comprehensive viva-voce (ESE) (External)

Components	Weightage
Comprehensive viva-voce(all courses from first semester to fourth semester)	15
Total	**15**

(Weightage of the components of the Comprehensive viva-voce(External) shall not be modified.)

12.8 **All grade point averages shall be rounded to two digits.**

12.9 To ensure transparency of the evaluation process, the internal assessment grade awarded to the students in each course in a semester shall be published on the notice board at least one week before the commencement of external examination.

12.10 **There shall not be any chance for improvement for Internal Grade.**

12.11 The course teacher and the faculty advisor shall maintain the academic record of each student registered for the course and a copy should be kept in the college for verification for at least two years after the student completes the programme.

12.12 **External Evaluation.** The external examination in theory courses is to be conducted by the College at the end of the semester. The answers may be written in English or Malayalam except those for the Faculty of Languages. The evaluation of the answer scripts shall be done by examiners based on a well-defined scheme of valuation. The external evaluation shall be done immediately after the examination.

12.13 Photocopies of the answer scripts of the external examination shall be made available to the students on request as per the rules prevailing in the University.

12.14 The question paper should be strictly on the basis of model question paper set and directions prescribed by the BOS.

12.15. **Pattern of Questions**

12.15.1 **Questions shall be set to assess knowledge acquired, standard, and application of knowledge, application of knowledge in new situations, critical evaluation of knowledge and the ability to synthesize knowledge. Due weightage shall be given to each module based on content/teaching hours allotted to each module.**

12.15.2 The question setter shall ensure that questions covering all skills are set.

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

12.15.4 The question shall be prepared in such a way that the answers can be awarded A+, A, B, C, D, E grades.

12.15.5 Weight: Different types of questions shall be given different weights to quantify their range as follows:

Sl.No.	Type of Questions	Weight	Number of questions to be answered
1	Short Answer type questions	1	8 out of 10
2	Short essay / problem solving type questions	2	6 out of 8
3	Long Essay Type questions	5	2 out of 4

12.16 **Pattern of question for practical**. The pattern of questions for external evaluation of practical shall be prescribed by the Board of Studies.

12.17 **DirectGradingSystem**

Direct Grading System based on a 6- point scale is used to evaluate the Internal and External examinations taken by the students for various courses of study.

Grade	Grade point(G)	Grade Range
A+	5	4.50 to 5.00
A	4	4.00 to 4.49
B	3	3.00 to 3.99
C	2	2.00 to 2.99
D	1	0.01 to 1.99
E	0	0.00

12.18 **Performance Grading**

Students are graded based on their performance (GPA/SGPA/CGPA) at the examination on a 7-point scale as detailed below.

Range	Grade	Indicator
4.50 to 5.00	A+	Outstanding
4.00 to 4.49	A	Excellent
3.50 to 3.99	B+	Very good
3.00 to 3.49	B	Good(Average)
2.50 to 2.99	C+	Fair
2.00 to 2.49	C	Marginal
up to 1.99	D	Deficient(Fail)

12.19 **No separate minimum is required for Internal Evaluation for a pass, but a minimum grade is required for a pass in an External Evaluation.**

However, a minimum C grade is required for pass in a Course

12.20 A student who fails to secure a minimum grade for a pass in a course will be permitted to write the examination along with the next batch.

12.21 **Improvement of Course**- The candidate who wish to improve the grade/grade point of the external examination of the of a course/ courses he/ she has passed can do the same by appearing in the external examination of the semester concerned along with the immediate junior batch. This facility is restricted to first and second semester of the programme.

12.22 **One Time Betterment Programme**- A candidate will be permitted to improve the **CGPA** of the programme within a continuous period of four semesters immediately following the completion of the programme allowing only once for a particular semester. The **CGPA** for the betterment appearance will be computed based on the **SGPA** secured in the original or betterment appearance of each semester whichever is higher.

If a candidate opts for the betterment of **CGPA** of a programme, he/she has to appear for the external examination of the entire semester(s) excluding practical /project/comprehensive viva-voce. One time betterment programme is restricted to students who have passed in all courses of the programme at the regular (First appearance)

12.23 **Semester Grade Point Average(SGPA) and Cumulative Grade Point Average (CGPA) Calculations.** The SGPA is the ratio of sum of the credit point of all courses taken by a student in a semester to the total credit for that semester. After the successful completion of a semester, Semester Grade Point Average(SGPA) of a student in that semester is calculated using the formula given below.

Semester Grade Point Average -SGPA (S_j) = $\sum(C_i \times G_i) / \sum C_i$

(SGPA= Total credit Points awarded in a semester / Total credits of the semester)

Where 'S_j' is the j^{th} semester, 'G_i' is the grade point scored by the student in the i^{th} course 'C_i' is the credit of the i^{th} course.

12.24 Cumulative Grade Point Average (**CGPA)** of a programme is calculated using the formula:-

Cumulative Grade Point Average (CGPA) = $\sum(C_i \times S_i) / \sum C_i$

(CGPA= Total credit Points awarded in all semester / Total credits of the programme)

Where 'C_i' is the credit for the i^{th} semester, 'S_i' is the SGPA for the i^{th} semester. The **SGPA** and **CGPA** shall be rounded off to 2 decimal points.

For the successful completion of semester, a student shall pass all courses and score a minimum **SGPA** of 2.0. However a student is permitted to move to the next semester irrespective of her/his **SGPA**

13. GRADE CARD

13.1 The Institution under its seal shall issue to the students, a consolidated grade card on completion of the programme, which shall contain the following information.

a) Name of the University.

b) Name of college

c) Title of the PG Programme.

d) Name of Semesters

e) Name and Register Number of students

f) Code, Title, Credits and Max GPA(Internal, External & Total) of each course (theory &practical), project, viva etc in each semester.

g) Internal, external and Total grade, Grade Point (G), Letter grade and Credit point (P) in each course opted in the semester.

h) The total credits and total credit points in each semester.

i) Semester Grade Point Average (SGPA) and corresponding Grade in each semester

j) Cumulative Grade Point Average (CGPA), Grade for the entire programme.

k) Separate Grade card will be issued.

l) Details of description of evaluation process- Grade and Grade Point as well as indicators, calculation methodology of SGPA and CGPA as well as conversion scale shall be shown on the reverse side of the grade card.

14. AWARD OF DEGREE - The successful completion of all the courses with 'C' grade within the stipulated period shall be the minimum requirement for the award of the degree.

15. MONITORING COMMITTEE

There shall be a Monitoring Committee constituted by the Principal to monitor the internal evaluations conducted.

16. RANK CERTIFICATE

Rank certificate shall be issued to candidates who secure positions 1st and 2nd. Candidates shall be ranked in the order of merit based on the CGPA secured by them. Grace grade points awarded to the students shall not be counted for fixing the rank. Rank certificate shall be signed by the Principal and the Controller of Examinations.

17. **GRIEVANCE REDRESSAL COMMITTEE**

17.1 Department level: The College shall form a Grievance Redressal Committee in each Department comprising of the course teacher and one senior teacher as members and the Head of the Department as Chairperson. The Committee shall address all grievances relating to the internal assessment grades of the students.

17.2. College level: There shall be a college level Grievance Redressal Committee comprising of faculty advisor, college co-ordinator, one senior teacher and one staff council member and the Principal as Chairperson.

18. **FACTORY VISIT / FIELD WORK/VISIT:** Factory visit / field work/visit to a reputed research institute/ student interaction with renowned academicians may be conducted for all Programmes before the commencement of Semester III.

19. **INTERNSHIP/ON THE JOB TRAINING:** Each student may undertake internship/on the job training for a period of not less than 15 days. The time, duration and structure of internship/on the job training can be modified by the concerned Board of Studies.

20. **TRANSITORY PROVISION**

Notwithstanding anything contained in these regulations, the Principal shall, for a period of three year 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.

21. **REPEAL**

The Regulations now in force in so far as they are applicable to programmes offered by the college and to the extent they are inconsistent with these regulations are hereby repealed. In the case of any inconsistency between the existing regulations and these regulations relating to the Credit Semester System in their application to any course offered in a College, the latter shall prevail.

22. **Credits allotted for Programmes and Courses**

22.1 Total credit for each programme shall be **80**.

22.2 Semester-wise total credit can vary from 16to25

22.3 The minimum credit of a course is 2 and maximum credit is 5

23. **Common Course:** If a course is included as a common course in more than one programme, its credit shall be same for all programmes.

24. **Course Codes:** The course codes assigned for all courses (Core Courses, Elective Courses, Common Courses etc.) shall be unique.

25. **Distribution of courses, course codes, type of the course, credits, teaching hours for PG Physics programme are given in the following table.**

Programmes with practical -Total Credits 80

Scheme of the syllabus-M Sc Physics

Semester	Course Code	Name of the courses	No of hrs / week	Credits
I	PG20PH101	Mathematical methods in Physics – I	3	3
	PG20PH102	Classical Mechanics	4	4
	PH20PH103	Electrodynamics	4	4
	PG20PH104	Electronics	4	4
	PG20PHP1	General Physics Practicals	10	4
		Total for Semester 1	**25**	**19**
II	PG20PH205	Mathematical methods in Physics – II	4	4
	PG20PH206	Quantum Mechanics – I	3	4
	PG20PH207	Statistical Mechanics	4	4
	PG20PH208	Condensed Matter Physics	4	4
	PG20PHP2	Electronics Practical	10	4
		Total for Semester II	**25**	**20**
III	PG20PH309	Quantum Mechanics – II	4	4
	PG20PH310	Computational Physics	4	4
	PG20PH311	Atomic and Molecular Physics	4	4
	PG20PH312	Elective – 1-Digital Signal Processing	3	3
	PG20PHP3	Advanced Practical in Electronics	10	5
		Total for Semester III	**25**	**20**
IV	PG20PH413	Nuclear and Particle Physics	5	4
	PG20PH414	Elective – 2-Microelectronics and Semiconductor Devices	5	3
	PG20PH415	Elective – 3-Communication Systems	5	3
	PG20PHP4	Computational Physics Practical	10	4
	PG20PH4P	Project	-	5
	PG20PH4V	Comprehensive viva voce	-	2
		Total for Semester IV	**25**	**21**
		Grand Total		**80**

The Elective Bunches:

There are two Electives Bunches offered in this PGCSS Program. Each elective consists of a bunch of three theory courses and one laboratory course. The first two theory course and the laboratory course of a bunch are placed in the Semester III, while the third is in Semester IV. In an academic year only one Elective Bunch can be selected. The course structure of the Electives Bunches is given in Table 1.2

The Electives Bunches are named,

(i) Bunch A : Electronics

(ii) Bunch B : Material Science

TABLE 1.2: THE ELECTIVE BUNCH

Bunch A: Electronics Specialization

Semester	Course Code	Course Title	No. of hrs / week	Credits
3	PG19PH311	Digital Signal Processing	3	3
3	PG19PH312	Micro Electronics and Semi Conductor Devices	5	3
4	PG19PH415	Communication Systems	5	3
3	PGPH4P2	Advanced Practical in Electronics	10	5

Bunch B: Materials Science Specialization

Semester	Course Code	Course Title	No. of hrs / week	Credits
3	PG19PH313	Solid State Physics for Materials	3	3
3	PG19PH314	Nanostructures and Materials Characterization	4	3
4	PG19PH416	Science of Advanced Materials	5	3
3	PGPH4P3	Advanced Practical in Materials Science	10	5

Distribution of Credit: The total credit for the program is fixed at 80. The distribution of credit points in each semester and allocation of the number of credit for theory courses, practical, project and viva is shown in Table 1.1 and Table1.2

Appendix

1. **Evaluation first stage – Both internal and external to be done by the teacher)**

Grade	Grade Points	Range
A+	5	4.50 to 5.00
A	4	4.00 to 4.49
B	3	3.00 to 3.99
C	2	2.00 to 2.99
D	1	0.01 to 1.99
E	0	0.00

The final Grade range for courses, SGPA and CGPA

Range	Grade	Indicator
4.50 to 5.00	A+	Outstanding
4.00 to 4.49	A	Excellent
3.50 to 3.99	B+	Very good
3.00 to 3.49	B	Good
2.50 to 2.99	C+	Fair
2.00 to 2.49	C	Marginal
Upto1.99	D	Deficient(Fail)

Theory-External-ESE

Maximum weight for external evaluation is 30. Therefore Maximum Weighted Grade Point (WGP) is 150

Type of Question	Qn. No.'s	Grade Awarded	Grade Point	Weights	Weighted Grade Point
Short Answer	1	A+	5	1	5
	2	-	-	-	-
	3	A	4	1	4
	4	C	2	1	2
	5	A	4	1	4
	6	A	4	1	4
	7	B	3	1	3
	8	A	4	1	4
	9	B	3	1	3
	10	-	-	-	
Short Essay	11	B	3	2	6
	12	A+	5	2	10
	13	A	4	2	8
	14	A+	5	2	10
	15	-	-	-	-
	16	-	-	-	-

	17	A	4	2	8
	18	B	3	2	6
Long Essay	19	A+	5	5	25
	20	-	-	-	-
	21	-	-	-	-
	22	B	3	5	15
			TOTAL	**30**	**117**

Calculation :
Overall Grade of the theory paper = Sum of Weighted Grade Points /Total Weight = 117/30 = 3.90 = Grade B

Theory-Internal-CE

Maximum weight for internal evaluation is 5. Therefore Maximum Weighted Grade Point (WGP) is 25.

Components	Weight (W)	Grade Awarded	Grade Point(GP)	WGP=W *GP	Overall Grade of the Course
Assignment	1	A	4	4	WGP/Total Weight= 24/5 =4.8
Seminar	2	A+	5	10	
Test Paper 1	1	A+	5	5	
Test Paper 2	1	A+	5	5	
Total	**5**			**24**	**A+**

Practical-External-ESE

Maximum weight for external evaluation is 15. Therefore Maximum Weighted Grade Point (WGP) is 75

Components	Weight(W)	Grade Awarded	Grade Point(GP)	WGP=W*GP	Overall Grade of the Course
Written/Lab Test	7	A	4	28	WGP/Total Weight= 58 / 15 = 3.86
Lab involvement & record	3	A+	5	15	
Viva	5	B	3	15	
Total	**15**			**58**	**B**

Practical-Internal-CE

Maximum weight for internal evaluation is 5. Therefore Maximum Weighted Grade Point (WGP) is 25

Components	Weight (W)	Grade Awarded	Grade Point(GP)	WGP=W *GP	Overall Grade of the Course
Written/ Lab Test	2	A	4	8	**WGP/Total**

Lab involvement & record	1	A+	5	5	**Weight=17/5 =3.40**
Viva	2	C	2	4	
Total	**5**			**17**	**B**

Project-External-ESE

Maximum weight for external evaluation is 15. Therefore Maximum Weighted Grade Point (WGP) is 75

Components	Weight (W)	Grade Awarded	Grade Point(GP)	WGP= W*GP	Overall Grade of the Course
Relevance of the topic & Analysis	3	C	2	6	**WGP/Total Weight = 56/15= 3.73**
Project Content & Presentation	7	A+	5	35	
Project Viva- Voce	5	B	3	15	
Total	**15**			**56**	**B**

Project-Internal-CE

Maximum weight for internal evaluation is 5. Therefore Maximum Weighted Grade Point (WGP) is 25

Components	Weight (W)	Grade Awarded	Grade Point(GP)	WGP=W *GP	Overall Grade of the Course
Relevance of the topic & Analysis	2	B	3	6	**WGP/Total Weight= 21/5 = 4.2**
Project Content & Presentation	2	A+	5	10	
Project Viva-Voce	1	A+	5	5	
Total	**5**			**21**	**A**

Comprehensive viva-voce-External-ESE

Maximum weight for external evaluation is 15. Therefore Maximum Weighted Grade Point (WGP) is 75

Components	Weight (W)	Grade Awarded	Grade Point(GP)	WGP=W*GP	Overall Grade of the Course
Comprehensive viva-voce	15	A	4	60	**WGP/Total Weight = 60 / 15 = 4**

Total	**15**			**60**	**A**

Comprehensive viva-voce-Internal-CE

Maximum weight for internal evaluation is 5. Therefore Maximum Weighted Grade Point (WGP) is 25

Components	Weight (W)	Grade Awarded	Grade Point(GP)	WGP=W *GP	Overall Grade of the Course
Comprehensive viva-voce	5	A+	5	25	**WGP/Total Weight = 25/ 5 = 5**
Total	**5**			**25**	**A+**

2. Evaluation Second stage-(to be done by the College)

Consolidation of the Grade(GPA) of a Course PC-1

The End Semester Evaluation (ESE) (External evaluation) grade awarded for the course PC-1 is A and its Continuous Evaluation (CE) (Internal Evaluation) grade is A. The consolidated grade for the course PC-1 is as follows

Evaluation	Weight	Grade awarded	Grade Points awarded	Weighted Grade Point
External	3	A	4.20	12.6
Internal	1	A	4.40	4.40
Total	**4**			**17**
Grade of a course.	GPA of the course =Total weighted Grade Points/Total weight= **17/4 =4.25 = Grade A**			

3. Evaluation Third stage-(to be done by the College)

Semester Grade Point Average (SGPA)

Course code	Titleof the course	Credits (C)	Grade Awarded	Grade Points(G)	Credit Points (CP=C X G)
01	**PC-1**	**5**	**A**	**4.25**	**21.25**
02	**-----**	**5**	**A**	**4.00**	**20.00**
03	**-----**	**5**	**B+**	**3.80**	**19.00**
04	**-----**	**2**	**A**	**4.40**	**8.80**
05	**-----**	**3**	**A**	**4.00**	**12.00**
TOTAL		**20**			**81.05**

SGPA	**Total credit points / Total credits = 81.05/20 = 4.05=** **Grade- A**

4. Evaluation Third stage-(to be done by the College)

<u>Cumulative Grade Point Average (CGPA)</u>

If a candidate is awarded three **A+** grades in semester 1(SGPA of semester 1), semester 2(SGPA of semester 2), semester 4(SGPA of semester 4) and **B** grades in semester 3(SGPA of semester 3). Then CGPA is calculated as follows:

Semester	Credit of the Semesters	Grade Awarded	Grade point (SGPA)	Credit points
I	20	A+	4.50	90
II	20	A+	4.60	92
III	20	B	3.00	60
IV	20	A+	4.50	90
TOTAL	**80**			**332**
CGPA= Total credit points awarded / Total credit of all semesters = 332 / 80= 4.15 **(Which is in between 4.00 and 4.49 in 7-point scale)** **Therefore the overall Grade awarded in the programme is A**				

ELIGIBILITY FOR ADMISSION TO M Sc PHYSICS PROGRAMME

Academic eligibility should be satisfied as on the last date of submission of academic data. No candidate shall be admitted to the PG programme unless he/she possess the qualifications and minimum requirements thereof, as prescribed by Mahatma Gandhi University from time to time.

If an applicant for admission is found to have indulged in ragging in the past or if it is noticed later that he/she had indulged in ragging, admissions shall be denied or he/she will be expelled from Mar Athanasius College (Autonomous), Kothamangalam.

Candidates should have passed the corresponding Degree Examination under the 10 + 2 + 3 pattern with one core/main subject and two complementary/subsidiary subjects from any of the Universities in Kerala or of any other University recognized by Mahatma Gandhi University as equivalent thereto for admission, subject to the stipulation regarding marks.

OR

Candidates who have passed Degree examination with Double or Triple main subject and candidates who have passed the Degree Examination in Vocational or Specialized Programmes are also eligible for admission. However, they have to submit copy of the Equivalency/Eligibility Certificate from Mahatma Gandhi University, stating that, their Qualifying Examination is recognized for seeking admission to the relevant P.G. Degree Programme(s) as applicable, at the time of admission. This provision is not applicable in the case of those applicants who have passed their qualifying examination from MG University.

The minimum requirements for admission to PG Physics Degree Programme are:

Graduates who have passed qualifying examination in CBCS (2017)/CBCSS (2013) pattern	Graduates who have passed qualifying examination in CBCSS (2009) pattern	Graduates who have passed qualifying examination in other patterns
Graduation in Physics or Electronic Equipment maintenance with not less than CGPA/CCPA of 5.00 out of 10.00in the Core Group (Core +Complementary + Open Courses)	Graduation in Physics or Electronic Equipment maintenance with not less than CGPA of 2.00 out of 4 in the Core Group (Core + Complementary + Open Courses)	Graduation in. Physics or Electronic Equipment maintenance with not less than 50% marks in the Part III subjects (Main/Core + subsidiaries/Complementaries) .
No weightage marks.		

The Open course under core group is taken only for reckoning the eligibility for applying for the PG programmes concerned. But a candidate cannot apply for the respective PG programmes solely on the basis of the open course selected under core group.

Relaxation in Marks in the qualifying examination:

(i) **Kerala Scheduled Caste/Scheduled Tribe Category**: The minimum grade in the qualifying examination for admission to the PG Degree programmes is 'C' in the seven point scale for CBCSS and a pass for pre CBCSS applicants.

(ii) **SEBC Category**: A relaxation of 3% marks in the qualifying examination from the prescribed minimum is allowed i.e. CGPA of 4.7 for CBCS (2017), CCPA of 4.7 for CBCSS (2013), and CGPA of 1.88 for CBCSS (2009) applicants and 47% marks for pre-CBCSS applicants for admission to M Sc. Programme in Physics.

(iii) **OEC Category:** A relaxation of 5% marks in the qualifying examination from the prescribed minimum is allowed i.e. CGPA of 4.5 for CBCS (2017), CCPA of 4.5 for CBCSS (2013), CGPA of 1.80 for CBCSS (2009) applicants and 45% marks for pre - CBCSS applicants for admission to M Sc. Programme in Physics.

(iv) **Persons with Disability category**: A relaxation of 5% marks in the qualifying examination from the prescribed minimum is allowed i.e. CGPA of 4.5 for CBCS (2017), CCPA of 4.5 for CBCSS (2013), CGPA of 1.80 for CBCSS (2009) applicants and 45% marks for pre – CBCSS applicants for admission to M Sc. Programme in Physics.

PROGRAMME OUTCOME (PO):

At the end of the programme, the graduate will be able to

PONo.	Upon completion of post graduate program, the students will be able to:
PO1	Create, apply and disseminate knowledge leading to innovation.
PO2	Think critically, explore possibilities and exploit opportunities positively
PO3	Work in teams, facilitating effective interaction in work places.
PO4	Lead a sustainable life.
PO5	Embrace life long learning.

PROGRAMME SPECIFIC OUTCOME (PSO):

At the end of the M.Sc. Physics programme the student will be able to:

No.	Outcome	PO-PSO Mapping
PSO1	Master analytic and critical thinking skills through acquired knowledge in major branches of physics.	1, 2
PSO2	Perform basic, applied and collaborative research.	2
PSO3	Enhance pedagogical and scientific writing skills through modern methods	3, 6
PSO4	Enhance National and International competency	1, 2
PSO5	Kindle entrepreneurial skills and life long learning	3, 5
PSO6	Become socially and environmentally responsible citizens.	4, 6

Scheme and Programme Structure -M Sc Physics
Total Credits 80

Semester	Course Code	Name of the courses	No of hrs / week	Credits
I	PG20PH101	Mathematical methods in Physics – I	3	3
	PG20PH102	Classical Mechanics	4	4
	PH20PH103	Electrodynamics	4	4
	PG20PH104	Electronics	4	4
	PG20PHP1	General Physics Practicals	10	4
		Total for Semester 1	**25**	**19**
II	PG20PH205	Mathematical methods in Physics – II	4	4
	PG20PH206	Quantum Mechanics – I	3	4
	PG20PH207	Statistical Mechanics	4	4
	PG20PH208	Condensed Matter Physics	4	4
	PG20PHP2	Electronics Practical	10	4
		Total for Semester II	**25**	**20**
III	PG20PH309	Quantum Mechanics – II	4	4
	PG20PH310	Computational Physics	4	4
	PG20PH311	Atomic and Molecular Physics	4	4
	PG20PH312	Elective – 1-Digital Signal Processing	3	3
	PG20PHP3	Advanced Practical in Electronics	10	5
		Total for Semester III	**25**	**20**
IV	PG20PH413	Nuclear and Particle Physics	5	4
	PG20PH414	Elective – 2-Microelectronics and Semiconductor Devices	5	3
	PG20PH415	Elective – 3-Communication Systems	5	3
	PG20PHP4	Computational Physics Practical	10	4
	PG20PH4P	Project	-	5
	PG20PH4V	Comprehensive viva voce	-	2
		Total for Semester IV	**25**	**21**
		Grand Total		**80**

CHAPTER II

1. M.Sc. PHYSICS SYLLABUS

INTRODUCTION

This chapter deals with the syllabi of all Core courses and Elective courses of the MSc. Physics program. The semester wise distribution of the courses is given.In the semester III and semester IV, the courses from elective bunch will come as opted by the college.

CORE COURSES

SEMESTER I

PG20PH101: MATHEMATICAL METHODS IN PHYSICS – I

Total Credits:3

Total Hours:54

Objective of the course: The objective of this course is to make students have an idea of vector, matrices and tensors, it's physical interpretation and applications.

Title of Paper	Mathematical methods in Physics – I	
Course Code	PG20PH101	
Semester	I	
Credits	3	
Contact Hours	54	
Course Type	Core Theory	
COURSE OUTCOMES (CO)		
On finishing the course, the student shall,		**PSO-CO Mapping**
CO1	Practice relevant mathematical methods used in physics	1, 4
CO2	Have a good understanding of the concepts and methods of vector and tensor analysis, linear algebra, coordinate transformations and Matrix	1, 4
CO3	Demonstrate skills in using linear algebra, vector and tensor analysis, coordinate transformations and Matrix in solving physics problems.	1, 4

UNIT I

Vector analysis (8 hrs)

Line, Surface and Volume integrals - Gradient, divergence and curl of vector functions – Gauss Divergence Theorem - Stoke's Theorem - Green's Theorem - Potential Theory -

Scalar Potential - Gravitational Potential, Centrifugal Potential

CURVILINEAR CO-ORDINATES (8HRS)

TRANSFORMATION OF CO-ORDINATES - ORTHOGONAL CURVILINEAR CO-ORDINATES - UNIT VECTORS IN CURVILINEAR SYSTEMS - ARC LENGTH AND VOLUME ELEMENTS - GRADIENT, DIVERGENCE AND CURL IN ORTHOGONAL CURVILINEAR CO-ORDINATES - SPECIAL ORTHOGONAL CO-ORDINATES SYSTEM - RECTANGULAR CARTESIAN CO-ORDINATES - CYLINDRICAL CO- ORDINATES - SPHERICAL POLAR CO-ORDINATES.

UNIT II

Linear vector space (8 hrs)

Definition of linear vector space - inner product of vectors - Basis sets - Gram Schmidt orthonormalization - expansion of an arbitrary vector - Schwarz inequality.

PROBABILITY THEORY AND DISTRIBUTION (6 HRS)

Elementary Probability Theory - Binomial Distribution - Poisson distribution - Gaussian Distribution - Central Limit Theorem

UNIT III

Matrices (12hrs)

Direct Sum and Direct Product of Matrices - Diagonal matrices - Matrices inversion (Gauss Jordan Inversion Methods) - Orthogonal, unitary and Hermitian Matrices - Pauli spin matrices, Dirac matrices, Normal Matrices - Cayley HamiltonTheorem - Similarity transformation - Orthogonal & Unitary Transformations - Eigen values & Eigen Vectors - Diagonalization using normalized Eigen vectors - Solution of linear equation Gauss Elimination method

UNIT IV

Tensors (12 hrs)

Definition of Tensors - Basic Properties of Tensors - Covariant, Contra variant & Mixed Tensors - Kronecker delta, Levi-Civita Tensor - Metric Tensor and its properties - Tensor algebra - Associated Tensors - Christoffel Symbols & their transformation laws - Covariant Differentiation - Geodesics

RECOMMENDED TEXT BOOKS:

1. Mathematical methods for Physicists, G.B. Arfken & H.J. Weber 5th edition, Academic Press.
2. Mathematical Physics, B.D.Gupta,Vikas Publishing House
3. Mathematical Physics , V.Balakrishnan, Ane Books Pvt Limited
4. Introduction to Mathematical Physics – Charles Harper, PHI
5. Vector Analysis & Tensor Analysis – Schaum's Outline Series, M.R.Speigel, McGraw Hill
6. Mathematical methods for physics and engineering, K F Riley, M P Hobson, S J Bence, Cambridge university press.
7. Tensor Calculus: Theory and Problems, A N Srivastava, Universities Press, 1992

RECOMMENDED REFERENCES:

1. An Introduction to Relativity, Jayant V. Narliker, Cambridge University Press.
2. Advanced Engineering Mathematics E.Kreyszig 7th edition, John Wiley
3. Mathematical Physics, B.S.Rajput,Y.Prakash 9th edition, Pragati Prakashan
4. Matrices and tensors in Physics, A.W.Joshi
5. Mathematical Physics, P. K. Chatopadhyay, New Age International Publishers
6. Mathematical Physics, Sathyaprakash, Sultan Chand & Sons

PG20PH102: CLASSICAL MECHANICS

Total Credits: 4

Total Hours: 72

Objective of the course:

After completing the course, the students will (i) understand the fundamental concepts of the Lagrangian and the Hamiltonian methods and will be able to apply them to various problems; (ii) understand the physics of small oscillations and the concepts of canonical transformations and Poisson brackets ; (iii) understand the basic ideas of central forces and rigid body dynamics; (iv) understand the Hamilton-Jacobi method and the concept of action-angle variables. This course aims to give a brief introduction to the Lagrangian formulation of relativisticmechanics.

Title of Paper		Classical Mechanics
Course Code		PG20PH102
Semester		I
Credits		4
Contact Hours		72
Course Type		Core - Theory
COURSE OUTCOMES (CO)		
On finishing the course, the student shall,		**PSO-CO Mapping**
CO1	Describe the evolution of Classical Mechanics as a discipline of science.	5
CO2	Understand the basic concepts of Lagrangian and Hamiltonian formulation	1
CO3	Apply the concepts of lagrangian and hamiltoinan formulations to various problems in Physics.	2
CO4	Understand the physics of small oscillations and concepts of canonical transformations and Poisson brackets.	1
CO5	Understand the basic ideas of central forces and rigid body dynamic.	1,2
CO6	Understand Hamilton-Jacobi method and the concept of action-angle variables	1
CO7	Have a brief idea about the Lagrangian formulation of relativistic mechanics	1
CO8	Apply the concepts in some common problems of mechanics.	2,4

UNIT 1

Lagrangian formulation (14 hrs)

Review of Newtonian Mechanics: Mechanics of a Particle; Mechanics of a System of

Particles; Constraints; - D' Alembert's principle and Lagrange's equations; velocity-Dependent potentials and the Dissipation Function; Lagrangian for a charged particle in electromagnetic field; - Application of Lagrange's equation to: motion of a single particle in Cartesian coordinate system and plane polar coordinate system; bead sliding on a rotating wire.- Hamilton's Principle; Technique of Calculus of variations; The Brachistochrone problem. - Derivation of Lagrange's equations from Hamilton's Principle. - Canonical momentum; cyclic coordinates; Conservation laws and Symmetry properties- homogeneity of space and conservation of linear momentum; isotropy of space and conservation of angular momentum; homogeneity of time and conservation of energy - Noether's theorem (statement only; no proof is expected).

HAMILTONIAN FORMULATION: (4HRS)

Legendre Transformations - Hamilton's canonical equations of motion; Hamiltonian for a charged particle in electromagnetic field. - Cyclic coordinates and conservation theorems; Hamilton's equations of motion from modified Hamilton's principle

UNIT II

Small oscillations (8hrs)

Stable equilibrium unstable equilibrium and neutral equilibrium; motion of a system near stable equilibrium-Lagrangian of the system and equations of motion - Small oscillations-frequencies of free vibrations; normal coordinates and normal modes - system of two coupled pendula-resonant frequencies normal modes and normal coordinates;free vibrations of CO2 molecule- resonant frequencies normal modes and normal coordinates.

CANONICAL TRANSFORMATIONS AND POISSON BRACKETS (10 HRS)

Equations of canonical transformations; Four basic types of generating functions and the corresponding basic canonical transformations. Examples of canonical transformations - identity transformation and point transformation. - Solution of harmonic oscillator using canonical transformations.Poisson Brackets ; Fundamental Poisson Brackets; Properties of Poisson Brackets - Equations of motion in Poisson Bracket form; Poisson Bracket and integrals of motion; Poisson's theorem; Canonical invariance of the Poisson bracket.

UNIT III

Central force problem (9hours)

Reduction of two-body problem to one-body problem; Equation of motion for conservative central forces - angular momentum and energy as first integrals; law of equal areas - Equivalent one-dimensional problem –centrifugal potential; classification of orbits. - Differential Equations for the orbit; equation of the orbit using the energy method; The Kepler Problem of the inverse square law force; Scattering in a central force field - Scattering in a Coulomb field and Rutherford scattering cross section.

RIGID BODY DYNAMICS (9HRS)

Independent coordinates of a rigid body; Orthogonal transformations; Euler Angles - Infinitesimal rotations: polar and axial vectors; rate of change of vectors in space and body frames - Coriolis effect - Angular momentum and kinetic energy of motion about a point - Inertia tensor and the Moment of Inertia; Eigenvalues of the inertia tensor and the Principal axis transformation - Euler equationsof motion - force free motion of a symmetrical top.

UNIT IV

Hamilton-Jacobi theory and action-angle variables(12 hrs)

Hamilton-Jacobi Equation for Hamilton's Principal Function - physical significance of the principal function- Harmonic oscillator problem using the Hamilton-Jacobi method - Hamilton-Jacobi Equation for Hamilton's characteristic function - Separation of variables in the Hamilton-Jacobi Equation - Separability of a cyclic coordinate in Hamilton-Jacobi equation - Hamilton-Jacobi equation for a particle moving in a central force field(plane polar coordinates) - Action-Angle variables - harmonic oscillator problem in action-angle variables.

CLASSICAL MECHANICS OF RELATIVITY (6 HRS.)

Lorentz transformation in matrix form - velocity addition; Thomas precession - Lagrangian formulation of relativistic mechanics - Application of relativistic Lagrangian to (i)motion under a constant force (ii) harmonic oscillator and (iii) charged particle under constant magnetic field.

RECOMMENDED TEXT BOOKS

1. Classical Mechanics: Herbert Goldstein , Charles Poole and John Safko, (3/e); Pearson Education.

RECOMMENDED REFERENCES:

2. Theory and Problems of Theoretical Mechanics (Schaum Outline Series): Murray R. Spiegel, Tata McGraw-Hill 2006.
3. Classical Mechanics : An Undergraduate Text: Douglas Gregory, Cambridge University Press.
4. Classical Mechanics: Tom Kibble and Frank Berkshire, Imperial College Press.
5. Classical Mechanics (Course of Theoretical Physics Volume 1): L.D. Landau and E.M. Lifshitz, Pergamon Press.
6. Analytical Mechanics: Louis Hand and Janet Finch, Cambridge University Press.
7. Classical Mechanics: N.C.Rana and P. S. Joag, Tata Mc Graw Hill.
8. Classical Mechanics: G. Aruldhas, Prentice Hall 2009.
9. Classical Mechanics: J.C. Upadhyaya, Himalaya Publications, 2010.
10. www.nptelvideos.in/2012/11/classicalphysics.html.

PG20PH103: ELECTRODYNAMICS

Total credits:4

Total hours:72

Objective of the course: Electromagnetic force is one of the four forces that exist in nature with a prominent role in the daily activities of human being. So it is necessary to know the physics of this force from the basics of two inter twinned phenomena called electricity and magnetism. Hence the course aims to impart proper understanding of electricity magnetism and electrodynamics; wave nature of electromagnetic field and its properties; electromagnetic field radiating out of accelerated charges and the impact of relativity in electromagnetism along with confined propagation of electromagnetic wave.

Title of Paper	Electrodynamics	
Course Code	PG20PH103	
Semester	I	
Credits	4	
Contact Hours	72	
Course Type	Core Theory	
COURSE OUTCOMES (CO)		
On finishing the course, the student shall,		**PSO-CO Mapping**
CO1	Analyse radiation phenomena from different charge and current distributions.	1, 4
CO2	Acquire analytical skills for basic and applied research in electrodynamic and data transmission systems.	2
CO3	Apply Maxwell's equations for problem solving in the static, steady state and time varying situations.	1
CO4	Compute field configurations inside rectangular waveguides and evaluate designs	1, 5

UNIT 1

Electrostatics, Magnetostatics and basics of Electrodynamics(18 hrs)

Electrostatics: Electric field of a polarized object- Electric field in a – conductor- dielectric -electric displacement -Gauss's law in dielectric medium-linear dielectric medium- Boundary condition across dielectric ($\varepsilon r1$)-dielectric ($\varepsilon r2$), conductor- dielectric (εr), conductor- free space ($\varepsilon r=1$) interface- Uniqueness theorem and electrostatic potential-Solving Poisson's and Laplace equations for boundary value problems - Method of images- point charge -line charge above a grounded conducting plane - Potential at large distance-multipole expansion due to a localized charge distribution-Electric field of a dipole- Magnetostatics: Biot-Savart law- divergence and curl of B- Ampere's law. Magnetic vector potential-multipole expansion of vector potential-boundary conditions - Magnetic field inside matter- Magnetization (M)- Magnetic flux density (B)- Auxiliary field (H)- Electrody namics: Electromotive force - motional emf - Faraday's law - electrodynamic equations - displacement current - Uniform sinusoidal time varying fields E and B and Maxwell's equations in free space and matter - Boundary conditions of electric and magnetic field - Conservation laws- continuity equation- Poynting's theorem-Maxwell'syou stress tensor- momentum conservation.

UNIT II

Electromagnetic waves (18 hrs)

Wave equation for E and B- monochromatic plane waves- energy- momentum - Propagation of em waves through linear media- Reflection and transmission of a plane wave at normal - oblique incidence - Electromagnetic waves in a conducting medium - Reflection at conducting surface- frequency dependence of permittivity - Dispersion of electromagnetic waves in non-conductors, conductors and plasma medium

UNIT III

Electromagnetic radiation (18 hrs)

Potential formulation of electrodynamics- Gauge transformations-Coulomb and Lorentz gauge - Continuous charge distribution-Retarded potential - Jefmenko's equation - Point charges - Lienard-Wiechert potentials-Field of a point charge in motion- Power radiated by a point charge - Electric dipole radiation-magnetic dipole radiation-radiation from arbitrary distribution of charges - Radiation reaction-Abraham-Lorentz formula.

UNIT IV

Relativistic electrodynamics and waveguides (18 Hrs)

Structure of spacetime- Four vectors-Proper time and proper velocity- Relativistic energy and momentum-Relativistic dynamics- Minkowski force. - Magnetism as a relativistic phenomenon. - Lorentz transformation of em field- field tensor - electrodynamics in tensor notation. - Potential formulation of relativistic electrodynamics - Waves between parallel planes - TE - TM-TEM waves - Rectangular waveguide- TE-TM waves -impossibility of

TEM wave.

RECOMMENDED TEXTBOOKS:

1. Introduction to Electrodynamics, David J. Griffiths, PHI.
2. Electromagnetics, John D.Kraus, McGraw-Hill International
3. Jordan & Balmain : Electromagnetics

RECOMMENDED REFERENCES:

1. Electromagnetic waves and radiating systems Edward C Jordan, Keith G Balamin, Printice Hall India Pvt.Ltd
2. Elements of Electromagnetic, Mathew N. O Sadiku, Oxford University Press
3. Antenna and wave propagation, K.D Prasad, Satyaprakashan, New Delhi
4. Electromagnetism problems with solutions, Ashutosh Pramanik, PHI.

PG20PH104: ELECTRONICS

Total credits:4

Total hours:72

Objective of the course: Electronics is the study of the flow of charge (electron) through various materials and devices such as semiconductors, resistors, inductors, capacitors, nanostructures etc. All applications of electronics involve the transmission of power and possibly information.

Title of Paper	Electronics	
Course Code	PG20PH104	
Semester	I	
Credits	4	
Contact Hours	72	
Course Type	Core Theory	
COURSE OUTCOMES (CO)		
On finishing the course, the student shall,		**PSO-CO Mapping**
CO1	Understand the fundamentals, characteristics and working of semiconductor devices	1
CO2	Analyze op-amp and its different configurations with their physical Operation	1
CO3	Design and analyze different applications of op-amps	1, 2
CO4	Evaluate frequency response to understand behavior of op-amps and electronics circuits using op-amps	1, 2
CO5	Demonstrate the ability to design practical circuits that perform the desired operations	2
CO6	Review of different modulation and demodulation techniques used in analog communication	1
CO7	Analyze transmitter and receiver circuits	1
CO8	Compare and contrast advantages, disadvantages and limitations of analog communication systems	1, 2
CO9	Analyze important types of integrated circuits.	1, 2
CO10	Select the appropriate integrated circuit modules to build a given application	4, 5

UNIT I

Op-amp with Negative Feedback (16 Hrs)

Differential amplifier–Inverting amplifier–Non-inverting amplifier - Block diagram representations–Voltage series feedback: Negative feedback –closed loop voltage gain - Difference input voltage ideally zero– Input and output resistance with feedback – Bandwidth with feedback–Total output offset voltage with feedback– Voltagefollower -

Voltage shunt feedback amplifier: Closed loop voltage gain-inverting\ input terminal and virtual ground - input and output resistance with feedback –Bandwidth with feedback -Total output offset voltage with feedback - Current to voltage converter – Inverter - Differential amplifier with one op-amp and two op-amps.

UNIT II

The Practical Op-amp (6 Hrs)

Input offset voltage –Input bias current – input offset current – 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 – Common mode configuration and CMRR.

GENERAL LINEAR APPLICATIONS (WITH DESIGN) (14HRS)

DC and AC amplifiers – AC amplifier with single supply voltage – Peaking amplifier – Summing, Scaling, averaging amplifiers - Instrumentation amplifier using transducer bridge Differential input and differential output amplifier – Low voltage DC and AC voltmeter - Voltage to current converter with grounded load - Current to voltage converter - Very high input impedance circuit – integrator and differentiator**.**

UNIT III

Frequency Response of an Op-amp (6 Hrs)

Frequency response –Compensating networks – Frequency response of internally compensated and non-compensated op-amps – High frequency op- amp equivalent circuit - Open loop gain as a function of frequency – Closed loop frequency response – Circuit stability - slew rate

ACTIVE FILTERS AND OSCILLATORS (12HRS)

Active filters – First order and second order low pass Butterworth filter - First order and second order high pass Butterworth filter - Wide and narrow band pass filter - wide and narrow band reject filter. All pass filter – Oscillators: Phase shift and Wien-bridge oscillators. - Square and triangular wave generators - Voltage controlled oscillator

UNIT IV

Comparators and Converters (8 Hrs)

Basic comparator- Zero crossing detector - Schmitt Trigger – Comparator characteristics- Limitations of op-amp as comparators - Voltage to frequency and frequency to voltage converters - D/A and A/D converters- Peak detector - Sample and Hold circuit.

IC555 TIMER (3 HRS)

IC555 Internal architecture - Applications IC565 – PLL - Voltage regulator ICs 78XX and 79XX

ANALOG COMMUNICATION (7 HRS)

Review of analog modulation – Radio receivers – AM receivers – superhetrodyne receiver - Detection and automatic gain control – communication receiver - FM receiver – phase discriminators – ratio detector - stereo FM reception

RECOMMENDED TEXT BOOKS:

1. Op-amps and linear integrated circuits R.A. Gayakwad 4thEdn.PHI
2. Electronic Communication Systems, Kennedy& Davis 4thEd.TMH,

RECOMMENDED REFERENCES:

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.

PG20PHP1: GENERAL PHYSICS PRACTICALS

Title of Paper	General Physics Practical	
Course Code	PG20PHP1	
Semester	I	
Credits	4	
Contact Hours	180	
Course Type	Laboratory Course	
COURSE OUTCOMES (CO)		
After successful completion of the course student will be able to		**PSO-CO Mapping**
CO1	Design, execute and collect data in an experiment. Master analytic and critical thinking skills through acquired knowledge in major branches of physics.	1,2
CO2	Conduct experiments as a team and through inter personal collaboration	2
CO3	Present experimental data as tables and graph and analyse data	2, 3, 5
CO4	Evaluate errors in the experiment and present it in a sensible way	2
CO5	Be honest in data collection and analysis	6
CO6	Become socially and environmentally responsible citizens.	

Total credits: 4

Total hours:180

** Minimum number of experiments to be done 12*

***Error analysis of the result is a compulsory part of experimental work*

1. Hall Effect in Semiconductor. Determine the Hall coefficient, carrier concentration and carrier mobility.
2. Ultrasonic- acoustics optic technique-elastic property of a liquid.
3. Magnetic susceptibility of a paramagnetic solution using Quinck's tube method.
4. Curie temperature of a magnetic material.
5. Dielectric Constant and Curie temperature of ferroelectric Ceramics.
6. Draw the hysteresis curve (B – H Curve) of a ferromagnetic material and determination of retentivity and coercivity.
7. Cornu's method- Determination of elastic constant of a transparent material
8. Determination of e/m by Thomson's method.
9. Determination of e/k of Silicon.
10. Determination of Planck's constant (Photoelectric effect).
11. Measurement of resistivity of a semiconductor by four-probe method at different

temperature and determination of band gap.

12. Determination of magnetic susceptibility of a solid by Guoy's method.
13. Measurement of wavelength of laser using reflection grating.
14. Fraunhoffer diffraction pattern of a single slit, determination of wavelength/slit width.
15. Fraunhoffer diffraction pattern of wire mesh, determination of wavelength/slit width.
16. Fraunhoffer diffraction pattern of double slit, determination of wavelength/slit width.
17. Diffraction pattern of light with circular aperture using Diode/He-Ne laser.
18. Fresnel diffraction pattern of a single slit.
19. Study the beam divergence, spot size and intensity profile of Diode/He-Ne laser.
20. Determine the numerical aperture of optical fibre and propagation of light through it.
21. Determine the refractive index of the material using Brewster angle setup.
22. Absorption bands of KMnO4 using incandescent lamp. Determine the wave lengths of the absorption bands. Determine the wave lengths of the absorption bands by evaluating Hartman's constants.
23. Determine the co-efficient of viscosity of the given liquid by oscillating disc method.
24. Measure the thermo emf of a thermocouple as function of temperature. Also prove that Seebeck effect is reversible.
25. Determine the Young's modulus of the material of a bar by flexural vibrations.
26. Using Michelson interferometer determine the wavelength of light.
27. Study the temperature dependence of dielectric constant of a ceramic capacitor and verify Curie-Wiess law
28. Study the dipole moment of an organic molecule (acetone).
29. Determine the dielectric constant of a non-polar liquid.
30. 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})
31. Determine the dielectric constant of a non-polar liquid.
32. Determine the charge of an electron using Millikan oil drop experiment.
33. Linear electro optic effect(Pockel effect), Frank Hertz experiment.
34. Frank Hertz experiment determination of ionization potential.
35. Koening's method, Poisson's ratio of the given material of bar.
36. Determination of Stefan's constant of radiation from a hot body.

REFERENCES

1. Advanced practical physics for students, B.L Worsnop and H.T Flint, University of California.
2. A course on experiment with He-Ne Laser, R.S Sirohi, John Wiley & Sons (Asia) Pvt.ltd
3. Kit Developed for doing experiments in Physics- Instruction manual, R.Srenivasan ,K.R Priolkar, Indian Academy of Sciences.
4. Advanced Practical Physics, S.P singh, PragatiPrakasan,
5. Practical Physics, Gupta, Kumar, PragatiPrakasan.
6. An advanced course in Practical Physics, D.Chattopadhayay, C.R Rakshit, New Central Book Agency Pvt. Ltd:

SEMESTER II

PG20PH205: MATHEMATICAL METHODS IN PHYSICS – II

Total Credits:4

Total Hours:72

Objective of the course: Introduce the concepts of Laplace and Fourier transforms. Introduce the Fourier series and it's application to solutions of partial differential equations.

Title of Paper		Mathematical methods in Physics – II
Course Code		PG20PH205
Semester		II
Credits		4
Contact Hours		72
Course Type		Core Theory
COURSE OUTCOMES (CO)		
On finishing the course, the student shall,		**PSO-CO Mapping**
CO1	Practice the method of contour integration to evaluate definite integrals of varying complexity	1, 2
CO2	Apply the method of Green's function to solve linear differential equations with inhomogeneous term	1, 2, 3
CO3	Solve partial differential equations using different methods.	3, 5
CO4	Get introduced to Special functions like Gamma function, Beta function, Delta function, Dirac delta function, Bessel functions and their recurrence relations	1
CO5	Learn different ways of solving second order differential equations and familiarized with singular points and Frobenius method	1, 2
CO6	Learn the fundamentals and applications of Fourier series, Fourier and Laplace transforms,their inverse transforms	1, 2
CO7		

UNIT 1

Complex analysis (18 hrs)

Functions of a complex variable - Analytic functions - Cauchy-Riemann equation - Integration in a complex plane - Cauchy Theorem - Cauchy's integral formulas - Taylor expansion & Laurent expansion - Residue, poles - Cauchy residue theorem - Cauchy's principle value theorem - Evaluation of integrals

UNIT II

Integral transforms (18 hrs)

Fourier Series - Application of Fourier series - Square Wave - Full Wave Rectifier - Fourier Integral - Fourier Transform - Finite Wave Train - Convolution Theorem of parseval's relation - Momentum representation - Hydrogen atom - Harmonic oscillator - Laplace Transform, Inverse Laplace transform - Earth Mutation - Damped Oscillator - LCR circuit

UNIT III

Special functions and differential equations (18 hrs)

Gamma Function - Beta Function - Symmetry Property of Functions - Evaluation of Beta functions - Other forms of Beta Functions - Transformation of Beta Functions - Evaluation of Gamma Functions - Other forms of Gamma Functions- Transformation of Gamma Functions - Relation between Beta and Gamma Functions - Evaluation of Integrals - Bessel's Differential Equation- Legendre Differential Equation - Associated Legendre Differential Equations - Hermite Differential Equations - Laguerre DifferentialEquations(Generating function, recurrence relation, orthogonality condition, Rodrigues formulae for all functions)

UNIT IV

Partial differential equations (18 hrs)

Characteristics of boundary conditions for partial differential equation - Solution of partial differential equations by the method of separation of variables in Cartesian, cylindrical and spherical polar co-ordinates - Solution of Laplace equation in cartesian, cylindrical and spherical polar co-ordinates - Heat equation in Cartesian co-ordinates - Non-Homogeneous equation - Green's function - Symmetry of Green's Function - Green's Function for Poisson Equation.

RECOMMENDED TEXT BOOKS:-

1. Mathematical methods for Physicists, G.B. Arfken& H.J. Weber 5th edition, Academic Press.
2. Mathematical Physics , V.Balakrishnan ,Ane Books Pvt Limited

RECOMMENDED REFERENCE BOOKS:

1. Advanced Engineering Mathematics E.Kreyszig 7thedition John Wiley

2. Mathematical Physics, B.S.Rajput, Y.Prakash 9th edition Pragati Prakashan
3. Mathematical Physics,B.D.Gupta ,Vikas Publishing House
4. Matrices and tensors in Physics,A.W.Joshi
5. Mathematical Physics , P.K.Chatopadhyay ,New Age International Publishers
6. Mathematical Physics, Sathyaprakash, Sultan Chand & Sons

PG20PH206: QUANTUM MECHANICS-I

Total Credits:4

Total Hours:54

Objective of the course:

This course aims to develop the basic structure of quantum Mechanics. After completing the course, the student will (i) understand the fundamental concepts of the Dirac formalism (ii) understand how quantum systems evolve in time; (iii) understand the basics of the quantum theory of angular momentum. Also, this course enable the student to solve the hydrogen atom problem which is a prelude to more complicated problems in quantum mechanics.

Title of Paper	Quantum Mechanics - I	
Course Code	PG20PH206	
Semester	II	
Credits	3	
Contact Hours	54	
Course Type	Core - Theory	
COURSE OUTCOMES (CO)		
On finishing the course, the student shall,		**PSO-CO Mapping**
CO1	Develop in students an idea of the basic structure of Quantum Mechanics.	1, 5
CO2	Understand the basic idea of Dirac Formalism	1, 2
CO3	Understand the use of operators and the concept of eigen values and eigen functions	1, 2
CO4	To get an idea of how quantum systems evolve in time	1, 2
CO5	Understand the quantum theory of angular momentum	1, 2
CO6	Enable the student to solve the hydrogen atom problem which is fundamental to more complicated problems.	1, 2, 6
CO7		

UNIT I

Basics Formulation of Quantum Mechanics (20 hours)

Development of the idea of state vectors from sequential Stern-Gerlach experiments - Dirac notation for state vectors - ket space, bra space andinner products – Operators - Associative axiom - outer product - Hermitian adjoint - Hermitian operator - Eigenkets and eigenvalues of Hermitian operators - Eigenkets of observables as base kets - concept of complete set - Projection operators - Matrix representations of operators - kets and bras - Measurements in quantum mechanics - expectation value - Compatible observables and existence of simultaneous eigenkets - General Uncertainty Relation - Unitary operator, change of basis and transformation matrix, unitary equivalent observables - Position eigenkets, infinitesimal translation operator and its properties, linear momentum as generator of translation, canonical commutation relations - Wavefunction as an expansion coefficient – eigenfunctions - momentum eigen function - momentum space wavefunctions and the relation between wave functions in position space and momentum space - Gaussian wave packet- computation of dispersions in position andmomentum

UNIT II

Quantum Dynamics (16 hours)

Time evolution operator and its properties - Schrodinger equation for the time evolution operator; solution of the Schrodinger equation for different time dependences of the Hamiltonian - Energy eigenkets - time dependence of expectation values - time evolution of a spin half system and spin precession - Correlation amplitude; time-energy uncertainty relation and itsinterpretation- Schrodinger picture and Heisenberg picture - behavior of state kets and observables in Schrodinger and Heisenberg pictures - Heisenberg’s equation ofmotion -Ehrenfest’s theorem - time evolution of base kets - transition amplitudes - Simple Harmonic Oscillator - Energy eigenvalues and energyeigenkets.

UNIT III

Theory of Angular Momentum (14 hours)

Non-commutativity of rotations around different axes; the rotation operator; fundamental commutation relations for angular momentum operators - rotation operators for spin half systems; spin precession in a magnetic field - Pauli’s two component formalism; 2X2 matrix representation of the rotation operator - ladder operators; eigenvalue problem for angular momentum operators - matrix representation of angular momentum operators - Orbital angular momentum ; orbital angular momentum as a generator of rotation - Addition of orbital angular momentum and spin angular momentum; addition of angular momenta of two spin- 1/2 particles - General theory of Angular Momentum addition-Computation of Clebsch-Gordoncoefficients.

UNIT IV

The Hydrogen Atom (4 hours)

Behaviour of the radial wave function near the origin - the Coulomb potential and the hydrogen atom - hydrogenic wavefunctions - degeneracy in hydrogen atom.

RECOMMENDED TEXT BOOKS:

1. ModernQuantumMechanics : J. J. Sakurai, PearsonEducation.
2. A Modern Approach to Quantum Mechanics: J S Townsend, VivaBooks.

RECOMMENDEDREFERENCES:

1. Quantum Mechanics (Schaum's Outline) :Yoav Peleg *etal*. Tata Mc Graw Hill Private Limited, 2/e.
2. Quantum Mechanics: 500 Problems with Solutions: G Aruldhas, Prentice Hall of India.
3. Quantum Mechanics Demystified: David McMohan, McGrawHill2006.
4. Introductory Quantum Mechanics: Richard L Liboff, Pearson Education.
5. Introduction to Quantum Mechanics: D.J. Grifith, PearsonEducation.
6. QuantumMechanics : V. K. Thankappan, New AgeInternational.
7. Quantum Mechanics: An Introduction: Walter Greiner and AllanBromley, Springer.
8. Quantum Mechanics : Non-Relativistic Theory(Course of Theoretical Physics Vol3): L. D. Landau and E. M. Lifshitz, PregamonPress.
9. The Feynman Lectures on Physics Vol3,Narosa.
10. www.nptel/videos.in/2012/11/quantum-physics.html
11. https://nptel.ac.in/courses/115106066

PG20PH207: STATISTICAL MECHANICS

Total Credits:4

Total Hours:72

Objective of the course:

This course aims to develop the basic structure of Statistical Mechanics. After completing the course, the student will (i) understand the fundamental concepts of thermodynamics and how it is related to statistical mechanics (ii) understand the basis of ensemble approach in statistical mechanics to a range of situations. (iii) understand statistical mechanics of identical particles and apply it to Fermi gas (iv) Analyze important examples of ideal Bose systems and Fermi systems. (iii) Develop and apply Ising model and mean field theory for first and second order phase transitions.

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<table>
<tr><td colspan="2">Title of Paper</td><td colspan="2">Statistical Mechanics</td></tr>
<tr><td colspan="2">Course Code</td><td colspan="2">PG20PH207</td></tr>
<tr><td colspan="2">Semester</td><td colspan="2">II</td></tr>
<tr><td colspan="2">Credits</td><td colspan="2">4</td></tr>
<tr><td colspan="2">Contact Hours</td><td colspan="2">72</td></tr>
<tr><td colspan="2">Course Type</td><td colspan="2">Core Theory</td></tr>
<tr><td colspan="4" align="center">COURSE OUTCOMES (CO)</td></tr>
<tr><td colspan="3">On finishing the course, the student shall,</td><td>PSO-CO Mapping</td></tr>
<tr><td>CO1</td><td colspan="2">Analyse statistical systems in thermal equilibrium.</td><td>1</td></tr>
<tr><td>CO2</td><td colspan="2">Apply quantum and classical methods for ideal statistical systems</td><td>1,3</td></tr>
<tr><td>CO3</td><td colspan="2">Explain statistical physics and thermodynamics as a logical consequences of the postulates of statistical mechanics</td><td>1, 4</td></tr>
<tr><td>CO4</td><td colspan="2">Perform quantitative calculations and formulate models of realistic systems</td><td>1, 3</td></tr>
<tr><td>CO5</td><td colspan="2">Analyse different systems such as ideal gas, Fermi gas, Bose gas and evaluate phase transitions</td><td>1, 4</td></tr>
<tr><td>CO6</td><td colspan="2">Develop and apply Ising model and mean field theory for first and second order phase transitions.</td><td>1,3,4</td></tr>
</table>

Unit I

Fundamental of Thermodynamics (10 Hrs)

Fundamental definitions – different aspects of equilibrium – functions ofstate – internal energy – reversible changes – enthalpy – heat capacities – reversible adiabatic changes in an ideal gas – second law of thermodynamics – the Carnot cycle - equivalence of the absolute and the perfect gas scale of temperature – definition of entropy- measuring the entropy – law of increase of entropy – calculations of the increase in the entropy in irreversible processes – the approach to equilibrium.

Text Book:

1. *Introductory Statistical Mechanics, R. Bowley& M. Sanchez, 2nd Edn. 2007, Oxford University Press, Indian Edition, (Chapter 1 and 2)*

Foundations of Statistical Mechanics (8 Hrs)

Ideas of probability – classical probability – statistical probability – the axioms of probability theory – independent events – counting the number of events – statistics and distributions – basic ideas of statistical mechanics - definition of the quantum state of the system – simple model of spins on lattice sites – equations of state – the second law of thermodynamics.

Text Book:

1. Introductory Statistical Mechanics, R. Bowley&M.Sanchez, 2nd Edn. 2007, Oxford University Press, Indian Edition, (Chapter 3 and 4)

Unit II

The Canonical Ensemble (12 Hrs)

A system in contact with a heat bath – the partition function – definition of the entropy in the canonical ensemble – the bridge to thermodynamics through partition function – condition for thermal equilibrium – thermodynamicquantities from partition function – case of a two level system – single particle in a one dimensional box – single particle in a three dimensional box – expression for heat and work – rotational energy levels for diatomic molecules – vibrational energy levels for diatomic molecules – factorizing the partition function – equipartition theorem – minimizing the free energy.

Text Book:

1. Introductory Statistical Mechanics, R. Bowley&M.Sanchez, 2nd Edn. 2007, Oxford University Press, Indian Edition, (Chapter 5)

Statistics of Identical Particles (4 Hrs)

Identical particles – symmetric and antisymmetricwavefunctions - bosons –fermions – calculating the partition function for identical particles – spin –identical particles localized on lattice sites.

Text Book:

1. *Introductory Statistical Mechanics, R. Bowley&M.Sanchez, 2nd Edn. 2007, Oxford University Press, Indian Edition, (Chapter 6)*

Unit III

Maxwell Distribution and Planck's Distribution (12 Hrs)

The probability that a particle is in a quantum state – density of states in k space – single particle density of states in energy – distribution of speeds of particles in a classical gas – blackbody radiation – Rayleigh-Jeans theory –Planck's distribution – derivation of the Planck's distribution – the free energy – Einstein's model vibrations in a solid – Debye's model of vibrations in a solid.

Text Book:

1. *Introductory Statistical Mechanics, R. Bowley&M.Sanchez, 2nd Edn. 2007, Oxford University Press, Indian Edition. (Chapter 7 and 8)*

Grand Canonical Ensemble (8 Hrs)

Systems with variable number of particles – the condition for chemical equilibrium – the approach to chemical equilibrium – chemical potential –reactions – external chemical potential – grand canonical ensemble –partition function – adsorption of atoms on surface sites – grand potential.

Text Book:

1. *Introductory Statistical Mechanics, R. Bowley& M. Sanchez, 2nd Edn. 2007, Oxford University Press, Indian Edition, (Chapter 9)*

Unit IV

Fermi and Bose Particles (6 Hrs)

Statistical mechanics of identical particles – thermodynamic properties of a Fermi gas – examples of Fermi systems – non-interacting Bose gas.

Text Book:

1. *Introductory Statistical Mechanics, R. Bowley&M.Sanchez, 2nd Edn. 2007, Oxford University Press, Indian Edition, (Chapter 10)*

Phase Transitions (12 Hrs)

Phases – thermodynamic potential – approximation – first order phase transition - Clapeyron equation – phase separation – phase separation inmixtures – liquid gas system – Isingmodel order parameter – Landau theory- symmetry breaking field – critical exponents.

Text Book:

1. Introductory Statistical Mechanics, R. Bowley&M.Sanchez, 2nd Edn. 2007, Oxford University Press, Indian Edition, (Chapter 11& 12)

Reference Books:

1. Statistical Mechanics, R.K. Pathria, & P.D. Beale, 2nd Edn, B-H(Elsevier) (2004).
2. Introductory Statistical Physics, S.R.A. Salinas, Springer (2000).
3. Fundamentals of Statistical and Thermal Physics, F. Rief, McGraw Hill (1986).
4. Statistical Mechanics, Kerson Huang, John Wiley and Sons (2003).
5. Statistical Mechanics, Satyaprakash& Agarwal, KedarNath Ram Nath Pub. (2004).
6. Problems and solutions on Thermodynamics and Statistical mechanics, Yung Kuo Lim, World Scientific Pub. (1990)
7. Fundamentals of Statistical Mechanics, A.K. Dasgupta, New Central Book Agency Pub. (2005)
8. Statistical Mechanics: a survival guide, A.M. Glazer and J.S. Wark, Oxford University Press. (2001).

PG20PH208: CONDENSED MATTER PHYSICS

Objective of the course:

This paper make the students aware of the field of Condensed Matter Physics enabling them to understand the structural properties of solids, about the crystal structure, interaction with X-ray, lattice vibrations, defects, electronic properties and the magnetic properties . It also helps the students to understand various properties about crystals. Thus the course aims to challenge the students to expand their knowledge of condensed matter physics and provide a foundation for further advanced studies.

Total Credits:4

Total Hours:72

Title of Paper	Condensed Matter Physics	
Course Code	PG20PH208	
Semester	II	
Credits	4	
Contact Hours	72	
Course Type	Core Theory	
COURSE OUTCOMES (CO)		
On finishing the course, the student shall,		**PSO-CO Mapping**
CO1	Have the knowledge and skills to explain the significance and value of condensed matter physics, both scientifically and in the wider community	1, 4
CO2	Be able to differentiate between different Lattice types and explain the concepts of reciprocal lattice and crystal diffraction	1, 3, 4
CO3	Be able to predict electrical and thermal properties of solids and explain their origin	1, 2, 4
CO4	Be able to explain the concept of energy bands and effect of the same on electrical properties	1, 4
CO5	Explain various types of magnetic phenomenon, physics behind them, their properties and applications.	1, 3, 4
CO6		

UNIT 1

Wave Diffraction and the Reciprocal Lattice (5Hrs)

Diffraction of waves by crystals - Bragg's Law-1.2reciprocal lattice vectors - diffraction condition - Laue equations - Ewald construction - Brillouin zones- reciprocal lattice to SC, BCC and FCC lattices - properties of reciprocal lattice - diffraction intensity - structure factor and atomic form factor.

Crystal Symmetry (7Hrs)

Crystal symmetry-symmetry elements in crystals-point groups, space groups - Ordered phases of matter - translational and orientational order - kinds of liquid crystalline order - Elements of Quasi crystals

Free Electron Fermi Gas (12 Hrs)

Energy levels in one dimension - quantum states and degeneracy - density of states - Fermi-Dirac statistics - Effect of temperature on Fermi-Dirac distribution –Free electron gas in three dimensions - Electronic specific heat - relaxation time and mean free path - Electrical conductivity and Ohm’s law - Widemann-Franz-Lorentz law - electrical resistivity of metals.

UNIT II

Energy Bands (8 Hrs)

Nearly free electron model- Origin of energy gap-Magnitude of the Energy Gap-Bloch functions –Kronig-Penney model– Wave equation of election in a periodic potential-Restatement of Bloch theorem-Crystal momentum of an Electron-Solution of the central equations- Brillouin zone- construction of Brillouin zone in one and two dimensions – extended, reduced and periodic zone scheme of Brillouin zone (qualitative idea only) - Effective mass of electron –Distinction between conductors, semiconductors and insulators.

Semiconductor Crystals (10 Hrs)

Band Gap-Equations of motion-Effective mass-Physical interpretation of effective mass-Effective mass in semiconductors-Silicon and Germanium-Intrinsic carrier concentration-Impurity conductivity-Thermal ionization of Donors and Acceptors-Thermoelectric effects – semimetals-super lattices-Bloch Oscillator-Zener tunnelling.

UNIT III

Phonons

Crystal Vibrations and Thermal Properties (16 Hrs)

Vibrations of crystals with monatomic basis – First Brillouin zone - Group Velocity - Two atoms per Primitive Basis –Quantization of elastic waves –Phonon momentum - Inelastic scattering by phonons. - Lattice specific heat – Einstein model - Density of States in one and three dimensions - Debye model- Debye T^3 Law - Anharmonicity and Thermal Expansion-Thermal Conductivity - thermal resistance of solids.

UNIT IV

Magnetic Properties of Solids (14 hrs)

Quantum theory of paramagnetism – Hund rules - crystal field splitting - spectroscopic splitting factor - Cooling by adiabatic demagnetization - Ferromagnetic order – Weiss theory of ferromagnetism - Temperature dependence of the spontaneous magnetism– Quantum theory of ferromagnetism - Ferromagnetic domains - domain model – domain theory - Antiferromagnetic order – antiferromagnetic susceptibility - Ferrimagnetism and ferrites - Magnons -Neutron Magnetic Scattering (qualitative idea only) - Single Domain Particles-Geomagnetism and Biomagnetism-Magnetic scope microscopy -GMR-CMR Effects (qualitative idea only).

Recommended Textbooks:

1. Solid State Physics: Structure and Properties of Materials, M A Wahab, Narosa (2015).
2. Elementary Solid State Physics, M. Ali Omar, Pearson, 4th Indian Reprint (2004).
3. Introduction to Solid State Physics, Charles Kittel, Wiely, Indian reprint (2015).
4. Solid State Physics, S O Pillai New Age International.

Recommended References:

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. Introduction to Solids, L V Azaroff, McGRAW-HILL BOOK COMPANY, INC.New York (1960)
2. Solid State Physics, R.L. Singhal, KedarNath Ram Nath& Co (1981)
3. Elementary Solid State Physics, M. Ali Omar, Pearson, 4th Indian Reprint (2004).
4. Solid State Physics, C.M. Kachhava, Tata McGraw-Hill (1990).
5. Elements of Solid State Physics, J. P. Srivastava, PHI (2004)
6. Solid State Physics, Dan Wei, Cengage Learning (2008)
7. Solid State Physics, J S Blackemore, Cambridge University Press (1985)
8. Electronic Properties of Crystalline Solids, Richard Bube, Academic Press New York (1974)
9.

PG20PHP2: ELECTRONICS PRACTICAL

Title of Paper		Electronics Practical
Course Code		PG20PHP2
Semester		II
Credits		4
Contact Hours		180
Course Type		Laboratory Course
COURSE OUTCOMES (CO)		
After successful completion of the course student will be able to		**PSO-CO Mapping**
CO1	Understand and evaluate the op-amp parameters	1, 2, 3
CO2	Understand the various applications of linear IC's like 741 and 555 timer	1, 2, 3, 4
CO3	Understand the need and requirements to obtain frequency response of an op-amp to design high frequency circuits	1, 2, 3
CO4	Define significance of Op Amps and their importance	1, 2, 3
CO5	Design and construct circuits using Analog IC's	1, 2, 3, 4
CO6	Apply the concepts in real time applications	1, 2, 3, 4
CO7	Construct electronic circuits using op-amps to generate sine, square and triangular wave forms	1, 2, 3, 4
CO8	Verify the filter circuits using op-amps and design the circuits for different applications	1, 2, 3,4
CO9	Design the VCO circuit using op-amp as well as BJTs and analyse its frequency response	1, 2, 3, 4
C10	Design various amplifiers using op-amp and observe their frequency responses	1, 2, 3
C11	Analyze the concepts of oscillators and observe their characteristics	1, 2, 3
C12	Design simple circuits using IC 555 and analyse their performance	1, 2, 3

Total credit: 4

Total hours: 180

* *Minimum number of experiments to be done 12*

***Error analysis of the result is a compulsory part of experimental work*

*** *PC interfacing facilities such as ExpEYES can be used for the experiments*

1. Op-Amp parameters (i) Open loop gain (ii) input offset voltage (iii) input bias current (iv)) CMRR (v) slew rate (vi) Band width
2. Design and construct an integrator using Op-Amp (*μA741)*, draw the input output

curve and study the frequency response.

3. Design and construct a differentiator using Op-Amp (*μA741) for sin wave and square wave input* and study the output wave for different frequencies.
4. Design and construct a logarithmic amplifier using Op-Amp (*μA741) and study the output wave form*.
5. Design and construct a square wave generator using Op-Amp (*μA741) for a frequency f0*.
6. Design and construct a triangular wave generator using (*μA741) for a frequency f0*.
7. Design and construct a saw tooth wave generator using Op-Amp (*μA741)* generator.
8. Design and construct an Op-Amp Wien bridge oscillator with amplitude stabilization and study the output wave form.
9. Design and construct a Schmidt trigger using Op-Amp μA741, *plot of the hysteresis curve.*
10. Design and construct an astable multivibrator using *μA741 with duty cycle other than 50%*
11. Design and construct a RC phase shift oscillator using *μA741for a frequency f0*.

12. Design and construct a first and second order low pass Butterworth filter using
13. *μA741 and plot the frequency response curve.*
14. Design and construct a first and second order high pass Butterworth filter using
15. *μA741 and study the frequency response.*
16. Design and construct a first order narrow band pass Butterworth filter using
17. *μA741.*
18. Solving differential equation using *μA741*
19. Design and construct ccurrent to voltage and voltage to current converter (*μA741*)
20. Astablemultivibrator using 555 timer, study the positive and negative pulse width and free running frequency.
21. Monostablemultivibrator using 555 timers and study the input output waveform.
22. Voltage controlled Oscillator using 555 timer
23. Design and construct a Schmitt Trigger circuit using IC 555.
24. Design and test a two stage RC coupled common emitter transistor amplifier and find th bandwidth, mid-frequency gain, input and output impedance.

25. Design and test a RC phase shift oscillator using transistor for a given operating frequency.
26. Voltage controlled Oscillator using transistor
27. Study the function of (i) analog to digital converter using IC 0800 (ii) digital to analog converter DAC 0808
28. Study the application of op-Amp (*µA741) as a d*ifferential amplifier.
29. Solving simultaneous equation using op-Amp (*µA741).*

REFERENCES:

1. Op-Amp and linear integrated circuitRamakanth A Gaykwad, Eastern Economy Edition, ISBN-81-203-0807-7
2. Electronic Laboratory Primer a design approachS. Poornachandra, B.Sasikala, Wheeler Publishing, New Delhi
3. Electronic lab manual Vol I, K A Navas, Rajath Publishing
4. Electronic lab manual Vol II, K A Navas, PHI eastern Economy Edition
5. Electronic lab manual Vol II, Kuriachan T.D, Syam Mohan, Ayodhya Publishing
6. An advanced course in Practical Physics, D.Chattopadhayay, C.R Rakshit, NewCentral Book Agency Pvt. Ltd

SEMESTER III

PG20PH309: QUANTUMMECHANICS-II

Total Credits: 4

Total Hours: 72

Objective of the course:

This course aims to extend the concepts developed in the course ‘ Quantum Mechanics-I . After completing this course, the student will (i) understand the different stationary state approximation methods and be able to apply them to various quantum systems; (ii) understand the basics of time-dependent perturbation theory and its application to semi-classical theory of atom-radiation interaction; (iii) understand the theory of identical particles and its application to helium; (iv) understand the idea of Born approximation and the method of partial waves. Also, this course will introduce the student to the basic concepts of relativistic quantum mechanics.

Title of Paper	Quantum Mechanics – II	
Course Code	PG20PH309	
Semester	III	
Credits	4	
Contact Hours	72	
Course Type	Core Theory	
COURSE OUTCOMES (CO)		
On finishing the course, the student shall,		**PSO-CO Mapping**
CO1	Understand the different stationary state approximation methods	1
CO2	Apply the approximation methods to various quantum systems	2
CO3	Understand the basic of time dependent perturbation theory	1
CO4	Apply the time dependent perturbation theory to classical theory of atom-radiation interaction	2
CO5	Understand the theory of identical particles	1
CO6	Apply the theory of identical particles to Helium	2, 3
CO7	Understand the idea of Born approximation and the method of partial waves	1
C08	Understand the basic concepts of relativistic quantum mechanics	1

UNIT I

Approximation Methods for Stationary States(18 hrs)

Non-degenerate Perturbation Theory: First order energy shift; first order correction to the energy eigenstate; second order energy shift. Harmonic oscillator subjected to a constant electric field. - Degenerate Perturbation theory First order Stark effect in hydrogen; Zeeman effect in hydrogen and the Landeg-factor - The variational Method; Estimation of ground state energies of harmonic oscillator and delta function potential 1.4 Ground State of Helium atom ; Hydrogen Moleculeion - The WKB method and its validity; The WKB wavefunction in the classical region; non-classical region ; connection formulas(derivation not required) - Potential well and quantization condition; the harmonic oscillator - Tunneling; application to alphadecay.

UNIT II

Time-Dependent Perturbation Theory (18 hrs)

Time dependent potentials; interaction picture; time evolution operator in interaction picture; Spin Magnetic Resonance in spin half systems -Timedependent perturbation theory; Dyson series; transition probability - constant perturbation; Fermi's Golden Rule ; Harmonic perturbation - interaction of atom with classical radiation field; absorption and stimulated emission; electric dipole approximation; photoelectric effect - Energy shift and decay width.

UNIT III

Identical Particles andScattering Theory (18hrs)

Bosons and fermions; anti-symmetric wave functions and Pauli's exclusion principle - The Helium Atom - The Asymptotic wave function - differential scattering cross section and scattering amplitude - The Born approximation- scattering amplitude in Born approximation; validity of the Born approximation; Yukawa potential ; Coulomb potential and the Rutherford formula. - Partial wave analysis- hard sphere scattering; S-wave scattering for finite potential well; Resonances and Ramsauer-Townsend effect .

UNIT IV

Relativistic Quantum Mechanics(18 hrs)

Klein-Gordon Equation; continuity equation and probability density in Klein- Gordon theory - Non-relativistic limit of the Klein-Gordon equation - Solutions of the Klein–Gordon equation for positive, negative and neutral spin0 particles; Klein-Gordon equation in the Schrodinger form - Dirac Equation in the Scrodinger form; Dirac's matrices and their properties - Solutions of the free particle Dirac equation; single particle interpretation of the plane waves; velocity operator; *zitterbewegung*- Non-relativistic limit of the Dirac equation; spin of Dirac particles; Total angular momentum as a constant of motion - Negative energy states and Dirac's hole theory.

RECOMMENDED TEXT BOOKS:

1. Modern Quantum Mechanics: J. J. Sakurai, PearsonEducation.
2. A modern Approach to Quantum Mechanics: John Townsend, Viva Books New Delhi
3. Introduction to Quantum Mechanics: D.J. Griffith, PearsonEducation
4. Relativistic Quantum Mechanics: Walter Greiner,Springer-Verlag

RECOMMENDED REFERENCES:

1. Quantum Mechanics (Schaum's Outline Series): Yoav Peleg etal., Tata McGraw Hill .Education Private Limited, 2/e.
2. Quantum Mechanics: 500 Problems with Solutions: G Aruldhas, Prentice Hall of India.
3. Problems and Solutions in Quantum Mechanics: Kyriakos Tamvakis, Cambridge UniversityPress.
4. Introductory Quantum Mechanics: Richard L Liboff, PearsonEducation.
5. QuantumMechanics: V. K. Thankappan, New AgeInternational.
6. A Textbook of Quantum Mechanics: P M Mathews and R Venkatesan, Tata McGraw Hill.
7. Quantum Mechanics: Non Relativistic Theory (Course of Theoretical Physics CourseVol3): L. D. Landau and E. M. Lifshitz, PregamonPress.
8. Relativistic Quantum Mechanics: James D Bjorken and Sidney D Drell,Tata McGraw Hill 2013
9. www.ntpel/videos.in/2012/11/quantum-physics.html
10. https://nptel.ac.in/courses/115106066/

PG20PH310: COMPUTATIONAL PHYSICS

Total Credits:4

Total Hours:72

Objective of the Course:

To help the students to have the basic idea about the techniques used in physics to solve problems with the help of computers when they cannot be solved analytically with pencil and paper since the underlying physical system is very complex. After the completion of this course students might be able to develop their own Algorithms of every method described in the syllabus.

<table>
<tr><td colspan="2">Title of Paper</td><td colspan="2">Computational Physics</td></tr>
<tr><td colspan="2">Course Code</td><td colspan="2">PG20PH310</td></tr>
<tr><td colspan="2">Semester</td><td colspan="2">III</td></tr>
<tr><td colspan="2">Credits</td><td colspan="2">4</td></tr>
<tr><td colspan="2">Contact Hours</td><td colspan="2">72</td></tr>
<tr><td colspan="2">Course Type</td><td colspan="2">Core - Theory</td></tr>
<tr><td colspan="4" align="center">COURSE OUTCOMES (CO)</td></tr>
<tr><td colspan="3">On finishing the course, the student shall,</td><td>PSO-CO Mapping</td></tr>
<tr><td>CO1</td><td colspan="2">A wide knowledge of numerical methods in computational Physics that can be used to solve many problems which does not have an analytic solution</td><td>1, 2</td></tr>
<tr><td>CO2</td><td colspan="2">Solve different numerical problems</td><td>1, 4</td></tr>
</table>

UNIT I

Curve Fitting and Interpolation (20Hrs)

The least squares method for fitting a straight line - The least squares method for fitting a parabola - The least squares method for fitting a power curve - The least squares method for fitting an exponential curve - Interpolation - Introduction to finite difference operators - Newton's forward and backward difference interpolation formula - Newton's divided difference formula - Cubic spline interpolation.

UNIT II

Numerical Differentiation and Integration(16 Hrs)

Numerical differentiation - errors in numerical differentiation - cubic spline method - Integration of a function with Trapezoidal Rule - Integration of a function with Simpson's 1/3-Rule - Integration of a function with Simpson's 3/8-Rule - Relevant Algorithms for each.

UNIT III

Numerical Solution of Ordinary Differential Equations (20Hrs)

Euler method - modified Euler method - Runge - Kutta 4^{th} order methods – adaptive step size R-K method - Higher order equations.

Numerical Solution of System of Equations

Gauss-Jordan elimination Method - Gauss-Seidel iteration method - Gauss elimination method - Gauss-Jordan method to find inverse of a matrix - Power method - Jacobi's method to solve eigenvalue problems.

UNIT IV

Numerical solutions of partial differential equations (16Hrs)

Elementary ideas and basic concepts in finite difference method - Schmidt Method - Crank - Nicholson method - Weighted average implicit method - Concept of Stability.

Recommended Text Books:

1. Numerical Methods for Scientists and Engineers , K SankaraRao, PHI Pvt. Ltd .
2. Introductory Methods of Numerical Analysis, S.S. Sastry, PHI Pvt. Ltd.

3. Mathematical Methods, G. Shanker Rao, K. Keshava Reddy, I.K. International Publishing House, Pvt. Ltd.

Recommended 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.KIyengar, 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, 4PthP Edn, 1958

PG20PH311: ATOMIC AND MOLECULAR PHYSICS

Total Credits: 4

Total Hours: 72

Objective of the course: This courseisintented todevelop the basic philosophy ofspectroscopy. Its aims to equip the student with the understanding of (1)atomic structure and spectra of typical one- electron and two-electron systems. (2)thetheory of microwave and infra-red spectroscopies as well as the electronic spectroscopy of molecules;(3)the basics of Raman spectroscopy and the nonlinearRaman effects; (4)the spin resonance spectroscopies such as NMR and ESR. This course also introduces the student to the ideas of Mossbauer spectroscopy .

Title of Paper	Atomic and Molecular Physics	
Course Code	PG20PH311	
Semester	III	
Credits	4	
Contact Hours	72	
Course Type	Core - Theory	
COURSE OUTCOMES (CO)		
On finishing the course, the student shall,		**PSO-CO Mapping**
CO1	Achieve advanced knowledge about the interactions of electromagnetic radiation and matter and their applications in spectroscopy	1, 2, 3, 4
CO2	Describe the atomic spectra of one and two valance electron atoms	1, 2, 3, 4
CO3	Explain the change in behavior of atoms in external applied electric and magnetic field	1, 2, 3, 4
CO4	Apply formalisms based on molecular symmetry to predict spectroscopic properties	1, 2, 3, 4
CO5	Explain rotational, vibrational, electronic and Raman spectra of molecules	1, 2, 3
CO6	Describe electron spin and nuclear magnetic resonance spectroscopy and their applications	1, 2, 3, 4
CO7	Master both experimental and theoretical working methods in atomic and molecular physics for making correct evaluations and judgments	1, 2, 3, 4
CO8	Apply the techniques of microwave and infrared spectroscopy to elucidate the structure of molecules	1, 2, 3, 4
CO9	Apply the principle of Raman spectroscopy and its applications in different fields of science & Technology	1, 2, 3, 4
CO10	Become familiar with different resonance spectroscopic techniques and its applications	1, 2, 3

UNIT 1

Atomic Spectra (18 Hrs)

1.1 The quantum mechanical treatment of hydrogen atom- quantum numbers *n*, *l* and *ml.*; spectra of alkali metal vapours 1.2 Derivation of spin-orbit interaction energy in hydrogen-like atoms; extension to penetrating orbits; fine structure in sodium atom

1.3 Normal Zeeman effect; Anomalous Zeeman effect- magnetic moment of the atom and g factor; spectral frequencies; Lande g-formula. 1.4 Paschen–Back effect – splitting of sodium D-lines ; Stark effect 1.5 L S coupling scheme -spectroscopic terms arising from two valence electrons; terms arising from two equivalent s-electrons; derivation of interaction energy -combination of s and p electrons; Hund's rule, Lande interval rule. 1.6 The jj coupling scheme in two electron systems -derivation of interaction energy-combination of s and p electrons ;Hyperfine structure .(qualitative ideas only).

UNIT II

Microwave and Infra Red Spectroscopy (18 Hrs)

2.1 Classification of molecules- linear, symmetric top, asymmetric top and spherical top molecules. 2.2 Rotational spectra of rigid diatomic molecules; 2.3 effect of isotopic substitution; intensity of spectral lines; energy levels and spectrum of non–rigid rotor

2.4Vibrational energy of a diatomic molecule- simple harmonic oscillator –energy levels; diatomic molecule as anharmonic oscillator- energy levels; infrared selection rules; spectrum of a vibrating diatomic molecule. 2.5 Diatomic vibrating rotator –P and R branches; break down of Born-Oppenheimer approximation. 2.6 Vibrations of polyatomic molecules – fundamental vibrations and their symmetry; overtone and combination frequencies; Analysis by IR techniques- skeletal vibrations and group frequencies.

UNIT III

Raman Spectroscopy and Electronic Spectroscopy. (18 Hrs)

3.1Quantum theory of Raman effect**;** classical theory-molecular polarizability ;Pure rotational Raman spectra of linear molecules 3.2 Raman activity of vibrations; rule of mutual exclusion; vibrational Raman spectra ;rotational fine structure 3.3 Structure determination from Raman and IR spectroscopy. 3.4 Non- linear Raman effects - hyper Raman effect - classical treatment; stimulated Raman effect - CARS, PARS - inverse

Raman effect. 3.5Electronic spectra of diatomic molecules –Born- Oppenheimer approximation, vibrational coarse structure-progressions and sequences; intensity of spectral lines- Franck – Condon principle 3.6 Dissociation energy and dissociation products; Rotational fine structure of electronic-vibrational transition ; Fortrat parabola; Predissociation.

UNIT IV

Spin Resonance Spectroscopy (18 Hrs)

4.1 Nuclear Magnetic Resonance(NMR)-resonance condition ; relaxation processes - Bloch equations 4.2 Chemical shift ; indirect spin–spin interaction 4.3 CW NMR spectrometer; Magnetic Resonance Imaging. 4.4 Electron Spin Resonance(ESR)- Principle of ESR; thermal equilibrium and relaxation; ESR spectrometer; characteristics of the g-factor. 4.5 Total Hamiltonian for an electron; Hyperfine Structure- ESR spectrum of hydrogen atom. 4.6 Mossbauer effect - recoilless emission and absorption; Experimental techniques in Mossbauer spectroscopy 4.7 Isomer shift; quadrupole interaction ; magnetic hyperfine interaction.

Recommended Text Books :

1. Spectroscopy, B.P. Straughan& S. Walker, Vol. 1, John Wiley &Sons
2. Introduction of Atomic Spectra, H.E. White, Mc Graw Hill.
3. Fundamentals of molecular spectroscopy, C.N. Banwell and E M McCash, TataMcGraw Hill Education Private Limited.
4. Molecular structure and spectroscopy, G. Aruldhas, PHI Learning Pvt. Ltd.

RECOMMENDED REFERENCES:

1. Spectroscopy (Vol. 2 & 3), B.P. Straughan& S. Walker, Science
2. paperbacks 1976
3. Raman Spectroscopy, D.A. Long, Mc Graw Hill international, 1977
4. Introduction to Molecular Spectroscopy, G.M. Barrow, Mc Graw Hill
5. Introduction to Spectroscopy, D L Pavia, G M Lampman and G S Kriz, Thomson Learning Inc.
6. Modern Spectroscopy, J M Hollas, John Wiley .
7. Elements of Spectroscopy, Gupta, Kumar & Sharma, PragathiPrakshan.
8. https:// teaching.shu.ac.uk/hwb/chemistry/tutorials/molspec/nmr1.htm
9. https://ntpel.ac.in/courses/15101003/downloads/modu21/lecture23.pdf

10. https://www.ias.ac.in/article/fulltext/reso/009/0034-0049

11. https://ntpel.ac.in/courses/122101001/downloads/modu21/lec-15.pdf

https://www.youtube.com/watch?v=Q2Fo5BARe Go

PG20PHP3: ADVANCED PRACTICAL IN ELECTRONICS

Title of Paper	Advanced Practical in Electronics	
Course Code	PG20PHP3	
Semester	IV	
Credits	5	
Contact Hours	180	
Course Type	Laboratory Course	
COURSE OUTCOMES (CO)		
After successful completion of the course student will be able to		**PSO-CO Mapping**
CO1	Design, construct and evaluate electronic circuits	1, 2, 3
CO2	Apply theoretical concepts in to practice	1, 2, 3
CO3	Train on scientific methodology in experimental problems	1, 2, 3
CO4	Familiarise with sophisticated instruments, data collection and analysis	1, 2, 3

Total credit: 5

Total hours: 180

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

[A] MICROPROCESSORS AND MICRO CONTROLLERS (USE A PC OR 8086-MP KIT)

1. Sorting of numbers in ascending/descending order.
2. Find the largest and smallest of numbers in array of memory.
2. Conversion of Hexadecimal number to ASCII and ASCII to Hexadecimal number.
3. Multi channel analog voltage measurements using AC card.
4. Generation of square wave of different periods using a microcontroller.
5. Measurement of frequency, current and voltage using microprocessors.

[B] COMMUNICATION ELECTRONICS

6. Generation PAM and PWM
7. Frequency modulation and demodulation using IC –CD4046.
8. Multiplexer and demultiplexer using digital IC 7432.
9. Radiation characteristics of a horn antenna.
10. Measurement of characteristic impedance and transmission line parameters of a

coaxial cable.

[C] ELECTRONIC INSTRUMENTATION

11. DC and AC milli-voltmeter construction and calibration.
12. Amplified DC voltmeter using FET.
13. Instrumentation amplifier using a transducer.
14. Generation of BH curve and diode characteristics on CRO.
15. Voltage to frequency and frequency to voltage conversion.
16. Construction of digital frequency meter.
17. Characterization of PLL and frequency multiplier and FM detector.

[D] OPTOELECTRONICS

18. Characteristic of a photo diode - Determination of the relevant parameters.
19. Beam Profile of laser, spot size and divergence.
20. Temperature co-efficient of resistance of copper.
21. Data transmission and reception through optical fiber link.

REFERENCES

1. Sedra, Adel S., Smith, Kenneth C., "Microelectronics Circuits", 5th Edition, Oxford University Press, NewYork.
2. Smith, Kenneth C., "Laboratory Explorations for Microelectronic Circuits", 4th
3. Edition, Oxford University Press, NewYork
4. Mims, Forrest, M., "Engineer's Mini-Notebook, Op-Amp Circuits", 2nd Edition, Siliconcepts
5. Microelectronics Circuit Analysis and Design, D. A. Neamen, McGraw Hill, 4th Edition
6. Electronics Lab Manual Volume 1,2,3 K. A. Navas, Rajath Publishers, Kochi Electronics lab Manuel, T D Kuryachan, S. Shyam Mohan, Ayodhya Publication.
7. Basic Electronics: A text. Zbar, Paul.B Lab Manual M C Graw Hill Tata
8. Edminister, Joseph, Electric Design, M C Graw Hill Tata

SEMESTER IV

PG20PH413: NUCLEAR AND PARTICLE PHYSICS

Total Credits: 4

Total Hours: 90

Objective of the course:

This course aims to provide the student to build up the fundamentals of nuclear and particle physics. After undergoing this course, the student will have a knowledge about (1) the basic properties of the nucleus and the nuclear forces. (2) Major models of the nucleus and the theory behind the nuclear decay process;(3) the physics of nuclear reactions (4) the interaction between elementary particles and the conservation laws in particle physics. This course intents to impart some idea about nuclear astrophysics and the practical applications of nuclearphysics.

Title of Paper	Nuclear and Particle Physics	
Course Code	PG20PH413	
Semester	IV	
Credits	5	
Contact Hours	90	
Course Type	Core Theory	
COURSE OUTCOMES (CO)		
On finishing the course, the student shall,		**PSO-CO Mapping**
CO1	To get an idea about the fundamentals of nuclear physics	1
CO2	Understand the basic properties of nucleus and the nuclear forces.	1
CO3	Major models of nucleus and the theory behind the nuclear decay	1, 2
CO4	Understand the physics of nuclear reactions	1
CO5	Understand the interaction between the elementary particles and the conservation laws in nuclear physics	1
CO6	Understand some idea about the nuclear astrophysics	1
CO7	Apply the ideas of nuclear physics in some practical situations	1, 2

UNIT I

Nuclear Properties and Force between Nucleons (18 Hrs)

The nuclear radius- distribution of nuclear charge (isotope shift, muonic shift, mirror nuclei); distribution of nuclear matter. Mass and abundance of nuclides, nuclear binding energy - Nuclear angular momentum and parity - Nuclear electromagnetic moments- quadrupole moment - The deuteron-binding energy, spin, parity, magnetic moment and electric quadrupole moment - Nucleon-nucleon scattering; proton-proton and neutron-nuetron interactions - Properties of nuclear forces - Exchange forcemodel.

UNIT II

Nuclear Models and Nuclear Decay (18 Hrs)

Liquid drop model, Bethe–Weizacker formula, Applications of semi- emperical binding energy formula - Shell Model-Shell model potential, Spin-orbit potential, Magnetic dipole moments, Electric quadrupole moments, Valence Nucleons - Collective structure- Nuclear vibrations, Nuclear rotations - Beta decay- energy release in beta decay ; Fermi theory of beta decay - Angular momentum and parity selection rules- allowed and forbidden transitions. Comparative half lives andforbidden decays; non-conservation of parity in beta decay - Gamma decay- angular momentum and parity selection rules ; internalconversion.

UNIT III

Nuclear Reactions (18Hrs)

Types of reactions and conservation laws, energetics of nuclear reactions, isospin - Reaction cross sections, Coulomb scattering- Rutherford formula, nuclear scattering - Scattering and reaction cross sections in terms of partial wave amplitudes - Compound-nucleus reactions - Direct reactions - Resonance Reactions.

UNIT IV

Particle Physics (18 Hrs)

Yukawa’s hypothesis; properties of pi mesons- electric charge, isospin, mass, spin and parity. - Decay modes and production of pi-mesons - Types of interactions between elementary particles, Hadrons and leptons - Symmetries and conservation laws, C P and CPT invariance, applications of symmetry arguments to particle reactions, parity non-conservation in weak interactions - Quark model, confined quarks, coloured quarks and gluons, experimental evidences for quark model, quark-gluon interaction, quark dynamics - Grand unified theories; standard model of particle physics; qualitative ideas of Higg’s boson and the LHCexperiments.

UNIT V

Nuclear Astrophysics and Practical Applications of Nuclear Physics(18 Hrs.)

Particleandnuclearinteractionsintheearlyuniverse,primordialnucleosynthesisStellar nucleosynthesis (for both $A<60$ and $A>60$) - Accelerator Mass Spectroscopy(AMS) and applications - Rutherford Backscattering spectroscopy and applications - Computerized Axial Tomography (CAT) - Positron Emission Tomography(PET)

RECOMMENDED TEXT BOOKS:

1. Introductory Nuclear Physics, K. S. Krane JohnWiley
2. Nuclear Physics: Problem-based Approach Including MATLAB, Hari M Agarwal, PHI Learning Private Limited, Delhi.
3. Nuclear Physics, S.N. Ghoshal, S. Chand &Company

RECOMMENDED REFERENCES:

1. Problems and Solutions in Atomic, Nuclear and Particle Physics: Yung-Kuo Lim, WorldScientific.
2. Nuclear Physics, S.N. Ghoshal, S. Chand &Company.
3. Introduction to Nuclear and Particle Physics : V M Mittal , R C Verma, S C Gupta (Prentice Hall India.
4. Concepts of Nuclear Physics: B L Cohen, TataMcGrawHill
5. Nuclear Physics: An Introduction – S B Patel, New AgeInternational.
6. Nuclear Physics: R R Roy and B P Nigam, New AgeInternational.
7. Nuclear Physics: R Prasad,Pearson.
8. Atomic Nucleus: R D Evans, Mc GrawHill, NewYork.
9. Nuclear Physics: I Kaplan, Narosa, New Delhi(2/e)
10. Nuclear and Particle Physics, B R Martin, John Wiley & Sons, New York, 2006.
11. Introduction to Elementary Particles : David Griffith,Wlley-VCH.
12. https://nptel.ac.in/course/115104043/
13. https://www.ias.ac.in/article/fulltext/reso/022/03/0245-0255
14. https://www.ias.ac.in/article/fulltext/reso/017/10/0956-0973
15. https://atlas.cern/updates/atlas-feature/higgs-boson

3.3 ELECTIVES

BUNCH A: ELECTRONICS

PG20PH312: DIGITAL SIGNAL PROCESSING

Total Credits: 3

Total Hours: 54

Objective of the Course: To study about discrete time signals and systems and to learn about FFT algorithms. To study the design techniques for FIR and IIR digital filters.

<table>
<tr><td colspan="2">Title of Paper</td><td colspan="2">Elective – 1-Digital Signal Processing</td></tr>
<tr><td colspan="2">Course Code</td><td colspan="2">PG20PH312</td></tr>
<tr><td colspan="2">Semester</td><td colspan="2">III</td></tr>
<tr><td colspan="2">Credits</td><td colspan="2">3</td></tr>
<tr><td colspan="2">Contact Hours</td><td colspan="2">54</td></tr>
<tr><td colspan="2">Course Type</td><td colspan="2">Core Theory</td></tr>
<tr><td colspan="4">COURSE OUTCOMES (CO)</td></tr>
<tr><td colspan="3">On finishing the course, the student shall,</td><td>PSO-CO Mapping</td></tr>
<tr><td>CO1</td><td colspan="2">Understand about various types of signals and systems, classify them, analyze them, and perform various operations on them</td><td>1, 2</td></tr>
<tr><td>CO2</td><td colspan="2">Understand the use of transforms in analysis of signals and system in continuous and discrete time domain</td><td>5</td></tr>
<tr><td>CO3</td><td colspan="2">Evaluate the time and frequency response of Continuous and Discrete time systems which are useful to understand the behaviour of electronic signal without any distortion</td><td>1, 3</td></tr>
<tr><td>CO4</td><td colspan="2">Compute various transform analysis of Linear Time Invariant System</td><td>5</td></tr>
<tr><td>CO5</td><td colspan="2">Apply engineering problem solving strategies to Digital Signal Processing</td><td>4, 5</td></tr>
<tr><td>CO6</td><td colspan="2">Design and test signal processing algorithms for various applications</td><td>1, 2</td></tr>
<tr><td>C07</td><td colspan="2">Design digital filters</td><td>2</td></tr>
</table>

UNIT I

Discrete time signals and Linear systems (16 Hours)

Examples of Signals -Classification of signals - System- Examples of discrete time - System models - Signal processing - Advantages,Limitations and applications of DSP- Elementary continuous time signals - Representation of discrete time signals - Elementary discrete time signals - Classification of discrete time signals - Operation on signals - Sampling and Aliasing - Discrete time system-Classifications - Representation of an arbitrary sequence-

Impulse response and convolution sum-properties – Causality-FIR,IIR,stable and unstable systems-Correlation of two sequences.

UNIT II

DSP Techniques (10 Hrs)

Frequency analysis of Discrete Time signals – Definition of Discrete Fourier transform-Frequency spectrum using DFT- Properties of Discrete Fourier transform-Relationship of the DFT to other transforms-Properties- Fast Fourier Transform (FFT) –Decimation in time algorithm –Radix- 2 FFT - 8 point DFT using Radix -2 DIT FFT

UNIT III

Z Transform (12 Hrs)

Z-Transform & ROC -properties - Z transform of finite duration,infinite duration and two sided sequence –System function – Poles and Zeros- Stability criterion - (Problems based on determination of Z trasform, ROC and Properties are expected)

UNIT IV

Digital Filters (16 Hrs)

IIR filters-frequency selective filters-Design of IIR filters from Analog filters-Approximation of derivatives -Design of IIR filter using impulse invariance Technique - Bilinear transformation-Direct form I structure of IIR systems - Cascade form realization of IIR systems - Realization of digital filters-Direct form I realization-Direct form II realization-FIR filters-Linear phase FIR filters-Design of FIR filter using rectangular window-The Fourier series method of designing FIR filters

RECOMMENDED TEXT BOOKS:

1. Digital Signal Processing, Fourth edition P. Ramesh Babu, Scitech
2. Digital signal Processing – A Nagoorkani, TataMcGrow Hill
3. Digital Signal Processing: Theory, Analysis and Digital-Filter Design, B.Somanathan Nair, PHI (2004)
4. Digital Signal Processing, Alan V. Oppenheim & R.W. Schafer, PHI
5. Digital Signal Processing -A practical Guide for scientists and Engineers- Steven W Smith

6. Digital signal processing -Hand book – Vijay K Madisetty &Douglas B Williams

RECOMMENDED REFERENCES:

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, John G. Proakis, Dimitris G. Manolakis, PHI
5. Digital signal processing, Sanjay Sharma, S.K. Kataria& Sons, 2010
6. Mathematical Methods for Physicists,G.B.Arfken &H.J.Weber.Elsavier, Academic Press
7. Digital signal Processing – V K Khanna S.Chand
8. Digital Signal Processing and Applications - Dag Stranneby&William Walker

PG20PH414: MICROELECTRONICS AND SEMICONDUCTOR DEVICES

Credits: 3

Number of hours: 90

Objective of the course: The objective of the course is to expose to the students to the architecture and instruction set of basic microprocessors. This course also covers fundamentals of semiconductor devices and their processing steps in detail. The student will be able to use the knowledge of semiconductor fabrication processes to work in industry in the area of semiconductor devices.

Title of Paper		Elective – 2-Microelectronics and Semiconductor Devices
Course Code		PG20PH414
Semester		IV
Credits		3
Contact Hours		90
Course Type		Core Theory
COURSE OUTCOMES (CO)		
On finishing the course, the student shall,		**PSO-CO Mapping**
CO1	Understand the architecture and instruction set of basic microprocessors	1
CO2	Analyse and solve simple programs using 8086 microprocessor machine language	2
CO3	Understand the architecture , instruction set and analyse basic programming concepts of 8051 microcontroller	2
CO4	Analyse the fundamentals of semiconductor devices and their processing steps	1
CO5	Apply the knowledge of semiconductor fabrication process used in industry in the area of semiconductor devices	1, 5

UNIT I

Introduction to microprocessors (20 Hrs)

Microprocessor organization- General organization of a microprocessor based microcomputer system - Memory organization – main memory array –memory management, cache memory, virtual memory - Input/output operation - Standard I/O – memory mapped I/O- interrupt driven I/O –DMA - 8085 Microprocessor – Architecture - 8085 addressing modes, instruction set, Pin out diagram - Simple programming concepts.

UNIT II

8086 Microprocessor (16 Hrs)

The Intel 8086- Architecture - MN/MX modes –Pin diagram - 8086 addressing modes - 8086 instruction set- instruction format- assembler directives and operators -.Programming with 8086- Familiarisation with Debug utility - Interfacing memory and I/O ports.

UNIT III

Microcontrollers (19 Hrs)

Introduction to microcontrollers and embedded systems - Comparison of microprocessors and microcontrollers - The 8051 architecture - Register set of 8051 – important operational features - I/O pins of 8051, ports and circuits - external memory - counters and timers – interrupts - Instruction set of 8051 - Basic programming concepts - Applications of microcontrollers - (basic ideas) – Embedded systems(basic ideas)

UNIT IV

Metal-semiconductor and semiconductor hetero-junctions(17Hrs)

Metal-semiconductor - Schottky barrier diode - qualitative characteristics – ideal junction properties- Current voltage relationship, Comparison with junction diode - Metal semiconductor ohmic contact - Ideal non rectifying barriers – tunneling barrier – specific contact resistances - Semiconductor hetero-junctions – hetero- junction materials – energy band diagram –Two dimensional electron gas - equilibrium electrostatics – current voltage characteristics.

UNIT V

INTEGRATED CIRCUIT FABRICATION AND CHARACTERISTICS (18 HRS)

Integrated circuit technology – basic monolithic IC – epitaxial growth –marking andetching - diffusion of impurities – transistor for monolithic circuit –Monolithic diodes – integrated resisters, capacitors and inductors-monolithic circuit layout - additional isolation methods - MSI, LSI, VLSI– the metal semiconductor contact.

RECOMMENDED TEXT BOOKS:

1. Microprocessor Architecture Programming and Applications with 8085, R.S. Gaonkar – Penram int. Pub. Mumbai

2. Fundamentals of Microprocessors and microcomputers- B. Ram (DhanpatRaiPub.)
3. Microprocessors and Microcomputer based system design, H. Rafiquizzaman, Universal Book stall, New Delhi
4. The 8051 microcontroller, Architecture Programming and Applications, Kenneth J Ayala- Penram Int. Pub. Mumbai
5. Semiconductor Physics and Devices, Donald A. Neamen, McGraw Hill
6. Integrated Electronics-Analogue and Digital Circuits and Systems, J Millmann and C C Halkias, TMGH

RECOMMENDED REFERENCES:

1. 0000 to 8085 Introduction to Microprocessors for Engineers and Scientists.- P.K. Gosh & P.R. Sridhar, PHI
2. Advanced microprocessors and peripherals, A.K. Ray & K.M. Burchandi –TMH
3. Microprocessor and microcontroller, R. Theagarajan- SCITECH Publications India Pvt. Ltd.
4. Microprocessor and Peripherals, S.P. Chowdhury& S. Chowdhury- SCITECH Publications.
5. Operating system Principles, Abraham Silberschatz& Peter Baer Galvin & Greg Gagne, John Wiley
6. Solid state electronic devices, Streetman and Banerjee, PHI (2010).
7. Physics of Semiconductor Devices, Michael Shur, PHI (2002).
8. Introduction to Semiconductor materials and Devices, M.S. Tyagi, John Wiley and Sons(2000)

PG20PH415: COMMUNICATION SYSTEMS

Total Credits:3

Total Hours:90

Objective of the Course :To understand the basic concepts of different communication systems.

Title of Paper		Elective – 3-Communication Systems
Course Code		PG20PH415
Semester		IV
Credits		3
Contact Hours		90
Course Type		Core Theory
COURSE OUTCOMES (CO)		
On finishing the course, the student shall,		**PSO-CO Mapping**
CO1	Have a basic understanding of two of the most important telecommunication systems - mobile and satellite communication systems.	1
CO2	Describe the development and functioning of mobile and satellite communication systems	1
CiO3	Understand the basic concepts of different communication systems	1, 4, 5
CO4	Use different modulation and demodulation techniques used in analog and digital communication	1, 2
CO5	Identify and compare different communication systems	1
CO6	Analyse mobile communication, satellite communication, fibre optication and radar systems	3, 4

UNIT I

Digital Communication(18 hrs)

Pulse Communication -Introduction - Pulse modulation :– PAM - PWM – PPM- PCM - PCM:– Sampling theorem- Quantisation-Noise Generation and demodulation of PCM- Companding-DPCM- ADPCM-Delta modulation - Information theory-Coding-Noise-Data Communication – Digital codes – Error detection and correction - Data sets and interconnection requirements-Modem classification and interfacings - Multiplexing techniques -Frequency division multiplex -Time division multiplex - Digital transmission techniques:-ASK- FSK- PSK-QPSK.

UNIT II

Mobile communication(20 hrs)

Introduction to Wireless Communication Systems-Mobile Radio System Around the World-Examples of wireless communication systems: - Paging system-Cordless Telephone System-Cellular Telephone System—How a Cellular Telephone Call is Made- Comparison of Common Mobile Radio Systems- Trends in Cellular and Personal Communications2.2 Wireless communication systems—2G-3G - 4G -The Cellular Concept-Frequency Reuse-Channel Assignment Strategies-Handoff Strategies:—Prioritizing handoffs and practical handoff consideration-Interference and System Capacity-Improving Coverage and Capacity in Cellular Systems:—Cell splitting- Sectoring-Microcell zone concept - Basic idea of Path Loss and Multipath Fading - Multiple Access Techniques –Introduction-FDMA-TDMA-SSMA:- FHMA-CDMA-Hybrid Spread Spectrum Techniques-SDMA - GSM.

UNIT III

Satellite Communication (16 hrs)

Satellite Communication Fundamentals-Satellite Orbits-Satellite Positioning- Frequency Allocations-Polarization-Antennas—gain-beam width-Multiple Access Techniques - Geostationary Satellite communication-Satellite parameters - VSAT (Basic Idea) - Geostationary Satellite Path/Link Budget - Satellite TV Systems- Satellite TV broadcasting - GPS.

UNIT IV

Fiber Optics Communication(20 hrs)

Introduction - Ray theory transmission-Total Internal Reflection-Acceptance Angle-Numerical aperture-Skew rays - Electromagnetic mode theory for optical propagation-Electromagnetic waves-Modes in a planar guide-Phase an group velocity - Fiber Classification-cylindrical fiber-Step Index- Graded Index-Single mode fiber:- Cut off wave length-Group delay -Photonic crystal fibers:-Index guided micro structures-Photonic band gapfibers - Dispersion:- chromatic-intermodal-Non linear effects - Optical fiber connection-Fiber Splices:-Fusion splices- Mechanical splices-Multiple splices-Fiber connectors:-Cylindrical ferrule connectors, Duplex and multiple-fiber connectors-Fiber couplers(basic idea).

UNIT V

Radar Systems (16 hrs)

Basic Principles –Fundamentals:- Basic radar Systems-Development of Radar- Radar Performance Factors - Radar range equation-factors influencing maximum range-Effects of noise- Target properties - Pulsed Systems-Block diagram and description-Antennas and

Scanning:-Antennas Scanning- Antenna tracking-Display Methods - Pulsed radar systems-Moving Target Indication:- Doppler Effect- Fundamentals of MTI-Delay Line- Blind speeds-Radar Beacons - Other radar systems-CW Doppler Radar-Frequency Modulated CW Radar-Phased Array Radars- Planar Array Radars.

RECOMMENDED TEXT BOOKS:

1. Electronic Communication Systems by Kennedy/Davis, Mc Graw Hill Publication, 4th edition,(Module-1 and 5).
2. Wireless Communication Principles and Practice by Theodore S Rappaport, Person Publication, 2nd Edition, (Module-2).
3. Telecommunication Transmission Systems by Robert G Winch, McGrawHill Publication,2nd edition,(Module-3).
4. Optical fiber communications-Principles and Practice John M Senior, Pearson publications, 3rd edition,(Module-4).

Recommended References:

1. Optical Fiber Communications by Gerd Keiser(Module-2).
2. Satellite Communications by Dennis Roddy,Mc Graw Hill Publication,3rd edition.
3. Introductions to RADAR Systems by Skolnik, McGraw Hill, 3rd edition
4. Satellite communication by Dr.D.C Agarwal.
5. Electronics Communication Systems by Wayne Thomas, Pearson Publication, 5 th Edition.

PG20PHP4 COMPUTATIONAL PHYSICS PRACTICALS

Title of Paper	Computational Physics Practical	
Course Code	PG20PHP4	
Semester	IV	
Credits	4	
Contact Hours	180	
Course Type	Laboratory Course	
COURSE OUTCOMES (CO)		
After successful completion of the course student will be able to		**PSO-CO Mapping**
CO1	Understands the basic concepts of computational methods in solving problems in physics	1
CO2	Acquire knowledge to apply and develop numerical methods	1, 3
CO3	Apply practical experiences on physical problems	5
CO4	Apply different methods to solve various scientific problems	1, 5
CO5	Identify modern programming methods and describe the extent and limitations of computational methods in physics	1, 2
CO6	Formulate and computationally solve a selection of problems in physics	3
CO7	Acquire knowledge about the role computer models and simulations play at studies of physical systems.	3, 5

Credits: 4

Number of hours: 180

NOTE

i. Develop algorithm / Flowchart for all experiments
ii. Codes can be developed in any package / programming language. Candidate should be trained to explain parts of the codesused.
iii. Plotting can be done in any plotting package and can be separate from the programming package /environment.
iv. Verify numerical results with analytical results whereverpossible.
v. Repeat experiments for various initial values / functions /step-sizes.
vi. Training may be given to use methods discussed below to solve real physicsproblems.

Introduction to computational facility in the Center

Introduction to the IDE used in the center and commands for execution of a program. Inputting data and variables, outputting results on a console. Achieving arithmetic operations and use of data and variables in the software used at the center . Usage of decisions and loops. Creating an array and using array operations. Method of declaring functions and function calling. Writing data to a file and reading data from a file. Getting a graph from a data available using plotting software available with the center.

1. Find the root of the given non-linear equations by the bisectionmethod
2. Find the root of the given non-linear equations by the Newton-Raphson method
3. A thermistor gives following set of values. Calculate the temperature corresponding to the given resistance using Lagrangeinterpolation.

Temperature	1101.0 K	911.3 K	636.0 K	451.1 K	273 K
Resistance	25.113 Ω	30.131 Ω	40.120 Ω	50.128 Ω	?

(This is only a sample data. Students should be capable to interpolate any set of data)

4. Newton's forward interpolation / backwardinterpolation.

5. Using appropriate technique and the given "Table", Calculate the pressure at the temperatureasked.

Steam Table

Temperature in C	140	150	160	170	180
Pressure kgf/cc	3.685	4.854	6.302	8.076	10.22

Temperature: 1750 C (This is only a sample data. Students should be capable to handle another set of data from any other physical phenomena)

6. Value of some trigonometric function [say f(θ) = tan (θ)] for θ=15,30,45,60,75 are given to you. Using appropriate interpolation technique calculate value of f(θ) for a givenvalue.

7. Numerical integration by the trapezoidalrule.
8. Using the trapezoidal rule, calculate the inner surface area of a parabolic reflecting mirror. (length of semi major axis , semi minor axis and height are to begiven)

9. Numerical integration by the Simpson rule (both 1/3 and 3/8rule).
10. Fit a straight line using method of least square to a set of given data without using any built in function of curve fitting. Compare your result with any built in curve

fittingtechnique.

11. Find out the normal equations and hence fit a parabola using method of least square to a set of given data without using any built in function of curve fitting. Compare your result with any built in curve fitting technique.
12. Fit a exponential curve to the given set of data using method of least square with out using any built in curve fitting technique. Compare your result with any built in curve fitting technique.
13. Study the given function as a sum of infinite series. Compare your valuewith the available standard value.
14. Numerical solution of ordinary first-order differential equations using the Euler methods or the fourth order Runge-Kutta method.
15. Using technique of Monte Carlo method obtain the value of π correct to two decimal places.
16. Using Monte Carlo technique calculate the value of the given integral. Compare your result with result obtained by analytical method.
17. Write a program to solve the given system of linear equations by the Gauss elimination method.
18. Find out inverse of a given matrix by using Gauss-Jordanmethod.
19. Numerical solution of second-order differential equations using the fourth order Runge-Kutta method.
20. Fast Fourier Transform of a givensignal.
21. Solution of Heat equation / Diffusion equation using Finite Difference Method.
22. A Duffing oscillator is given by $\ddot{x}+\delta\dot{x}+\beta x+\alpha 3=\gamma cos\omega t$ where $\delta$is damping constant >0. Write a program to study periodic and a periodic behavior
23. Study of path of a Projectile in motion with and with out air drag and compare the values.
24. A study of Variation of magnetic field B(T) with critical temperature in superconductivity
25. Generation of output waveform of a Half wave / full wave rectifier.
26. Charging /discharging of a capacitor through an inductor and resistor
27. Variation in phase relation between applied voltage and current of aseriesL.C.R circuit

28. Phase plot of a pendulum (driven and damped pendulum)
29. Study variation of intensity along a screen due to the interference from Young's double slit experiment. Also study the variation of intensity with variation of distance of the screen from the slit.
30. Study variation of intensity along a screen due to the diffraction due to a grating . Also study the variation of intensity with variation of distance of the screen from the grating.
31. A particle obeying F-D statistics is constrained to be in 0 to 2eV at 300K. Calculate Fermi energy of this particle assuming kT =.025eV at300K
32. Solve the following differential equation and study periodic and a periodic behavior. $dxdt=\sigma(y-x),dydt=x(\rho-z)-y,dzdt=xy-\beta z$
33. Study the difference equation xn+1=(1−xn) and obtain periodic and a periodic behavior.
34. Generate a standing wave pattern and study change in pattern by changing its various parameters.

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.

BUNCH B

MATERIAL SCIENCE

SOLID STATE PHYSCIS FOR MATERIALS

Total Credits: 3

Total Hours: 54

UNIT 1

Crystal defects [18h]

Crystal Imperfection- point imperfections- vacancy, Frenkel and Schottky imperfections – Dislocations- Edge, screw, Burger's vector critical resolved shearstress - Dislocation motion , dislocation reaction, dislocation energy,slip - Surface and volume imperfections – stacking faults; Fracture, twinning [Ref.5] - Voids in close packing- size, coordination andsignificance - Pauling's rule and applications; Allotropy, polymorphism [Ref. 4] - polytypism

UNIT II

(A) Atomic Diffusion[6h]

Fick's laws - solution andapplications - Kirkendall effect - Atomic model of diffusion and other diffusion processes and mechanisms

(B) CRYSTAL BINDING:[12H]

Crystals of inert gas, Van der Waals- London interaction, Repulsive interaction, equilibrium lattice constants, cohesiveenergy - Ionic crystals- Madelung energy, Madelungconstant - Covalent crystals, metals, hydrogen bond; Born-Habercycle

UNIT III

(A) Phase diagrams:[6h]

Phase diagram rules, unary and binary phasediagrams - microstructural changes during cooling,applications

(B) EXCITATIONS IN SOLIDS[12H]

Plasma optics,plasmons - Polaritons, LSTrelation - electron-phonon interaction:polarons -

Kramers Kronig Relations - excitons- Frenkel and Wannier excitons - electron hole drops - Magnons- spin wave quantization and thermal excitation ofmagnons

RECOMMENDED TEXTBOOKS:

1. Materials Science and Engineering- VRaghavan-PHI
2. Introduction to solid state physics- C Kittel- WileyIndia
3. Solid State Physics- Wahab-Narosa

RECOMMENDED REFERENCES:

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

NANOSTRUCTURES AND MATERIALS CHARACTERISATION

Total Credits:3

TOTAL HOURS: 72

UNIT 1

Nanostructures: Synthesis and properties [25 h]

Applications of Schrodinger equation in nanoworld: particle confined in one dimension, quantum leak, penetration of barrier, - nanostructures for electronics- quantum dots, nanowires, superlattices and heterostructures - Preparation of quantum nanostructures, size and dimensionality effects, single electron tunnelling. Metal nanoclusters, semiconducting nanoparticles, rare gas and molecular clusters. Self assembly and catalysis - Synthesis routes: bottom up approaches- PVD, CVD, MBE, PLD, wet chemical- top down synthesis routes- mechanical alloying, nanolithography.

Nanomaterials and applications [2 h]

Carbon nanostructures: carbon clusters, fullerenes, CNTs- fabrication, properties and applications , 2-D nanostructure- graphene [Ref 6]

UNIT II

Optical Absorption and Emission spectroscopy [20 h]

Instruments for absorption photometry – radiation sources, wavelength selection, cells and sampling devices, detectors; Fundamental laws of photometry (Beer Lambert’s law), spectrophotometric accuracy, precision, absorptivity, bathochromic and hypsochromic shift, Jablonski diagram - Principles of Fourier transform optical measurements- advantages of Fourier transform spectrometry, time domain spectrometry, fourier transform of interferograms- optical atomic spectra- atomic line widths, effect of temperature - Principles and applications of Differential, difference and derivative spectroscopy, photoacoustic and thermal lens spectroscopy; General applications of uv absorption spectroscopy - Theory of fluorescence and phosphorescence spectrophotometry, PL power, total luminescence spectroscopy, fluorescence lifetime measurements, quenching and applications, principleand applications of chemiluminescence, Qualitative ideas of resonanceraman spectroscopy, surface enhanced ramanspectroscopy,

UNIT 111

Chemical, thermal and X-ray diffraction methods [25 h]

X ray diffraction- production and detection of X-rays and X-ray spectra, Moseley's law, Geometry of an X-ray diffractometer, [Ref 3] - X-ray photoelectron spectroscopy, X-ray fluorescence, Particle size determination, Debye Scherrer formula, stress measurementAuger recombination, Auger Emission Spectroscopy - Working of SEM, TEM, AFM and STM with instrumentation - Mass spectrometry: ionization methods, mass spectrometers and analyzers, correlation of mass spectra with molecular structure. - Thermal methods: thermogravimetry, DTA, DTG, DSC, microthermal analysis; Principles of pH measurement, potentiometry, voltammetry and electrogravimetry

RECOMMENDED TEXT BOOKS: (UNIT 1)

1. Introduction to nanotechnology: Charles P Poole, Frank J Owens-Wileyindia
2. Textbook of nanoscience and nanotechnology- B S Murty, P Shankar, Baldev Raj, B B Rath, 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 UniversityPress.

RECOMMENDED TEXT BOOKS: (UNIT 2&3)

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 UniversityPress.
4. Principles of Instrumental analysis- Holler, Skoog,Crouch-Cenage

RECOMMENDED REFERENCES:

1. Instrumental methods of chemical analysis-Chatwal, Anand-Himalaya
2. Instrumental methods of chemical analysis- Galen WEwing-MGH
3. X ray diffraction a practical approach :C Suryanarayana, M GrantNorton; Springer

4. Nanophotonics- Paras N Prasad:Wiley
5. Nanostructures and nanomaterials- G Cao and Y Wang- WorldSci.
6. Graphene: Synthesis, Properties and Applications in Transparent electronic devices- P Kumar etal- Reviews in Advanced Sciences and Engineering, vol 2, pp1-21, 2013

SCIENCE OF ADVANCED MATERIALS

Total Credits:3

Total Hours:90

UNIT 1:

Ceramics, polymers and composites [25h]

(A) Ceramics:

Types, properties and applications of ceramics: Glass, clay, refractories, abrasives, cements, advanced ceramics, piezoelectricceramics - mechanical and glass properties, heat treatment of glasses, Perovskite structure, Classification of ferroelectric materials, dielectric breakdown [Ref3].

(B) POLYMERS:

polymer structure and configurations,thermosetting and thermoplastic , copolymers, conducting polymers, mechanical behaviour ofpolymers - Mechanisms of deformation and strengthening, crystallization, melting and glass transition; polymer types-plastics, elastomers, fibers, polymerisation and applications.

C) COMPOSITE MATERIALS:

particle reinforced composites, fiber –reinforced composites, structural composites,Semimetals

UNIT II

(A) Optical properties of materials [10h]

Absorption processes, photoconductivity, photovoltaic effect, colour centers- types andgenerationLuminescence – photoluminescence, cathodoluminescence, electroluminescence, injection luminescence, radiative recombinationGaussian Beam- Amplitude, properties, quality; [Ref 1]Optical coherence- temporal, spatial [Ref2]

(B) LASERS[10H]:

Absorption of radiation, threshold conditions, lineshape function, population inversion and pumping threshold conditions, lasermodes,semiconductor lasers, hetero junction lasers. Methods of pulsing lasers – Q switching and modelocking

UNIT III

Photonic materials and Applied Photonics [20h]

LEDs [5h]:

Principles, structure, materials and characteristics, heterojunction LED, SLED and ELED

Solar cells [5 h]

Principles, characteristics, PERL, heterojunction, cascaded, and schottky barrier cells, material and design considerations [Ref5] - Basic concepts and features of Photonic crystals, [Ref 6] Liquid crystals, [Ref 7] optics of metamaterials, [Ref 1] Amorphous semiconductors. [Ref 7] detector arrays-CCDsElectro-optic effect, magneto-optic effect, acousto-opticeffect.

UNIT IV

Superconductors, Thin films and crystal growth [25 h]

(A) Superconductors: [12 h]

Thermodynamics andelectrodynamics - BCS theory, flux quantization, type I &IIsuperconductors - single particle tunnelling, Josephson tunnelling, high temperaturesuperconductors

(B) THIN FILMS:[7H]

Nature- deposition technology-Resistance heating, Cathodic sputtering, interferometric film thickness measurement, Applications: Antireflectioncoating, solar cells andsensors.

(C) CRYSTALGROWTH:[6H]

Mechanism of crystal growth, nucleation, classification of crystal growth methods, growth from melt-Czochralski, Bridgeman, Floatzone techniques, growth from solution - gel growth. [Ref 8,11]

RECOMMENDED TEXT BOOKS:

1. Solid State Physics- Wahab-Narosa;
2. Optoelectronics- Wilson & Hawkes- Pearson2018;
3. Optoelectronics- Wilson & Hawkes- Pearson2018;
4. Optoelectronics and Photonics: Principles and Practices- S O Kasap-Pearson
5. Introduction to solid state physics- C Kittel- WileyIndia
6. Thin film fundamentals: A Goswami- New Age;
7. Semiconductor Physics and devices, S.S. Islam, Oxford Universitypress.

RECOMMENDED REFERENCES:

1. Fundamentals of Photonics- Saleh and Teich- wileyIndia;
2. Lasers and Nonlinear Optics: B B Laud; New Age,
3. Solid State Physics- S O Pillai- NewAge;
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. Crystal growth: processes and methods- P.S. Raghavan and P. Ramasamy, KRU publications
9. Materials Science and Engineering- VRaghavan-PHI.
10. Essentials of Crystallography- M A Wahab- Narosa
11. Semiconductor Devices: Physics and Technology- S M Sze- WileyIndia
12. Fiber optics and Optolelectronics- R P Khare-Oxford

ADVANCED PRACTICALS IN MATERIAL SCIENCE

Total credit: 5

Total hours: 180

** Minimum number of experiments to be done 12*

***Error analysis of the result is a compulsory part of experimental work*

1. Malu's law-verification
2. Optical activity- specific rotationmeasurement
3. Stefan's constant- torch bulb filament resistance measurement
4. Absorption coefficient of solution- path length and concentrationdependence
5. XRD- Crystal Structure DeterminationCubic/Hexagonal
6. XRD-Lattice ParameterMeasurements
7. XRD- Phase DiagramDetermination
8. XRD-Determination of Crystallite Size and Lattice Strain
9. Zeeman effect- shift of atomic energylevels
10. Laser- measurement of thread angle, pitch and the diameter of a micrometre screw
11. Thin film thickness- Newton's rings/ Michelsoninterferometer
12. Magneto-optic effect - Determination of Verdetconstant
13. Michelson interferometer /Edser Butler method/ Fresnel's biprism- mica sheet thickness
14. Bandgap- semiconductordiode
15. Laser –Young's double slit -interference
16. Refractive index of liquid- Newton's ring /Laser/ Fresnel'sbiprism
17. Resolving power- lens-Laser
18. Rydberg constant- Hydrogen dischargetube
19. Particle size – coronaplate
20. Comparison of thickness of thin sheets by airwedge
21. Band gap and type of optical transition (direct or Indirect using Tauc relation) from absorptionspectra
22. Synthesis of metallic (Ag or Au) nanoparticles in aqueous medium and estimation particle size using absorptionspectrum

23. Thermal analysis of materials from experimentaldata
24. Analysis of FTIR spectrum
25. Solar cell- efficiency& Fillfactor
26. Laser diffraction- comparison of thickness of wires of differentgauges
27. Thermistor –parameters [energy bandgap]
28. Temperature sensor- silicon diode andthermocouple
29. Optical fiber- bendingloss
30. Fermi energy ofcopper
31. ESR spectrometer- gfactor
32. Verification of laws of geometrical optics- reflection and transmission coefficients, critical angle, refractive index of glass slab/prism
33. Study of Bravais lattices with the help ofmodels
34. Verification of Fresnel's equations
35. Spring constant-static and dynamicmethod
36. Coherence length ofLED
37. Comparison of resistance variation of a carbon film resistor, metalwire, semiconductor and thermistor withtemperature
38. Thermal diffusivity ofbrass
39. Young's modulus- straingauge
40. Michelson interferometer- Sodium D linesseparation
41. Fresnel's biprism- wavelength of monochromaticlight

REFERENCES:

1. A course of experiments with He-Ne laser- R S Sirohi,Wiley
2. Practical Physics- C L Arora, SChand
3. X ray diffraction a practical approach :C Suryanarayana, M GrantNorton; Springer
4. Practical Physics: D Chattopadhyay, P C Rakshit; New Central BookAgency
5. Advanced practical physics: Chauhan, Singh; PragatiPrakashan

MODEL QUESTION PAPER

M.Sc. DEGREE EXAMINATION

Semester 1

PG20PH104 – ELECTRONICS

Time: 3hours Total Weight : 30

Part A

(Answer any EIGHT questions, weight 1 each)

1. Draw the symbol and characteristics of an N - channel FET and mark linear region, saturation region and breakdown region.
2. Explain why open loop op-amp configurations are not used in linear applications.
3. Explain CMRR and slew rate of an op - amp.
4. What is the effect of negative feedback in non inverting amplifiers.
5. Draw the circuit of a differential input and differential output amplifier and write the expression for its gain.
6. What are instrumentation amplifiers. Draw the block diagram of an instrumentation system.
7. What are the advantages of active filters over passive filters.
8. What is a comparator?
9. What is the need for a low pass filter in PLL?
10. Of all frequencies that must be rejected by a superhetrodyne receiver, why is image frequency so important?

Part B

(Answer any SIX questions, weight 2 each)

11. For a given op – amp, CMRR = 100dB and differential gain = 105. Determine the common mode gain of op – amp.

12. Design a closed loop non – inverting amplifier circuit that is capable of providing a voltage gain of 10. Assume an ideal operational amplifier.Take the output for a load of 10 k .(Values of the resistors should not exceed 30 k).Draw the circuit and mark the components.

13. Draw the circuit of a low voltage ac voltmeter.Design a voltmeter to measure input voltages up to 2V using 1mA full - scale meter movement and 100 number of divisions.

14. Design a second order low – pass filter at a high cut off frequency of 1kHz and passband voltage gain of 1.586. Take the value of capacitance as 0.0047 μ F and feedback resistor R_F = 15.82 k.What changes will you make to get a new cut off frequency of 1.2kHz.

15. What is a current to voltage convertor. With a proper circuit, derive an expression for output voltage in terms of feedback resistance and input current.What is the output voltage for an input current of 10mA and a feedback resistance of 2 k

16. (a) The input signal of a voltage follower is Vin= V_P sinωt. Show that the slew rate = $2\pi f V_P 10^{-6}$ V/μ s, where f is the input frequency.

(b) An inverting amplifier using the 741C must have flat response up to 40kHz. The gain of the amplifier is 10. What peak to peak input signal can be applied without distorting the output if the slew rate of 741C is 0.5 Volt/μ s?

17. What is a differential amplifier? With a circuit and necessary theory, derive expressions for voltage gain

18. Explain an integrator and derive an expression for its output voltage.

Part C

(Answer any TWO questions, weightage-5)

19. (i) With a block diagram, explain voltage shunt feedback.(ii) With necessary circuit and theory of non inverting amplifier with voltage shunt feedback, derive expressions for voltage gain and input resistance with feedback.

20. Using inverting configuration of an op – amp, explain (i) summing amplifier (ii) scaling amplifier and (iii) averaging amplifier.

21. Discuss with necessary theory, the working of a second order high pass filter.

22. Discuss the working of a communication receiver with a suitable block diagram

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