Maharaja's College Ernakulam

A GOVERNMENT AUTONOMOUS COLLEGE

Re-Accredited by NAAC with 'A Grade'
Affiliated to Mahatma Gandhi University
Centre of Excellence under Govt. of Kerala
Identified by UGC as College with Potential for Excellence

POST GRADUATE AND RESEARCH
DEPARTMENT OF PHYSICS

Estd. 1875

Post Graduate Curriculum and Syllabus
(Credit Semester System)

M. Sc. PHYSICS

For 2022 Admission Onwards

Maharaja's College, Ernakulam

(A Government Autonomous College affiliated to M. G. University)

Curriculum and Syllabus
(2022 Admission onwards)

for

Master of Science (M.Sc.) Programme in Physics

Under
Credit Semester System (CSS)

Department of Physics, Maharaja's College, Ernakulam, Kerala, India, PIN 682011

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I.PREFACE

The PG syllabus in Physics is restructured to meet the NAAC requirement to determine new learning objectives and to revise the present curriculum. The course objectives and course outcomes are made part of the model curriculum to ensure development of specialized knowledge and relevant skill. The philosophy of drafting model curriculum for PG level programme has been evolved through elaborate major specifications in various fields of Physics. In the restructuring of the PG syllabus, the Board of Studies has taken into account the emerging trends in the various fields of theoretical and experimental physics.

Meeting of the Board of Studies of the Department of Physics, Maharaja's College held on 04-02-2022 on virtual platform at 2pm recommended further modifications on existing syllabus by not more than 15 % so as to address the content overload and lack of logical sequence. The thrust was given to inculcate in students the spirit of hard work and research aptitude to pursue higher education in the nationally/internationally reputed institutions and also to crack UGC/CSIR examinations.

The following members attended the Board of Studies meeting.

1. Dr. Zeenath N. A. (Chairman)
2. Prof. Sabu Thomas (Alumni Member)
3. Dr. N. Shaji (External Subject expert)
4. Dr. Prasanth R. (External Subject expert)
5. Mr. Robin Francis (Internal Member)
6. Mrs. Sreeja R. (Internal Member)
7. Mrs. Sheeja V. (Internal Member)
8. Dr. Sivakumar C. (Internal Member)
9. Mrs. Viji C. (Internal Member)
10. Mrs. Sheeba P. X. (Internal Member)
11. Dr. Rekha S. (Internal Member)
12. Dr. Gishamol Mathew (Internal Member)
13. Dr. Wilson K.C. (Internal Member)
14. Mrs. Mary Linsa K.S. (Internal Member)

The Board of Studies decided to propose the following to the Academic Council:

To make the modules of the syllabi almost of the same teaching hours and of the same weight by the necessary rearrangements.

To remove the content overload in the syllabus of the courses generally.

Specifically,

In *Mathematical methods in Physics I* of Semester I, to remove tensor calculus as it is in detail a part of the course *Gravitation and Cosmology* of semester IV.

In *Classical Mechanics* of Semester I, to divide Module I into *Lagrangian formulation* and *Hamiltonian formulation* and to include the necessary examples.

In *Electrodynamics* of Semester I, to add the basics to have a better clarity of the topic.

In *Electronics* of Semester I, to delete *instrumentation amplifier* of module II; *minimum and maximum operation* of module II

In *Mathematical methods in Physics II* of Semester II, to remove *Laguerre equation and the related topics* to reduce the size of Module I of the course.

In *Quantum mechanics II* of Semester III, to rearrange Module III for a little more clarity.

In *Statistical Mechanics* of Semester II, to rearrange the syllabus to have an even distribution of contact hours in the modules; to remove *Non-equilibrium statistics* with the aim of lightening the syllabus; to remove *Heat capacity of solids* as it is taught in *Solid state Physics*.

In *Solid state Physics* of Semester II, to remove *Diffraction intensity, atomic, geometrical and crystal structure factors and its significance* of module I; to remove *Extended, Reduced and Periodic zone schemes* of module II; *Anharmonic crystal interactions, thermal expansion, thermal conductivity, lattice thermal resistivity, Unklapp process and imperfections* of module III.

In the elective course *Astrophysics* of Semester III, to include the advanced topic *evaporation of black holes.*

In the elective *Quantum Field Theory* of Semester IV, to include the basic concepts in Module II and IV.

In the elective *Semiconductor device physics and Microelectronics* of Semester III, to delete *8051 Microcontroller advanced instructions and advanced programming examples.*

In *Photonics* of Semester IV, to add to module I, *transmission, total internal reflection and acceptance angle* and to delete *polarization maintaining fibres and modal birefringence* from it; to include in Module II, the basics of *LASER;* to delete *metallic nanostructures and its applications* from Module IV.

In *Electronic Communication and Digital Signal Processing (DSP)* of Semester IV, to remove *Transmission line theory* from Module I; to retain *Analogue and Digital Communication* as Module I; to split Module III of the existing syllabus into Module III for *FIR filters* and Module IV for *IIR filters*; to change the teaching hours for DSP as 52 as in the existing syllabus *DSP* was given 40 teaching hours (DSP of the same content is a 54 hour-topic in the MG University Syllabus for PG), teaching this paper in 40 hours is a strenuous task.

In the elective lab *Special Computational Practicals* of Semester IV, to give importance to simulations of the theoretical models.

To reduce the number of text books, one text book preferably for the continuity of developing the topic using the same notations and symbols.

I sincerely thank the external subject experts Dr. N Shaji, Adjunct Professor, Cochin University of Science and Technology, Dr. Prasanth R, Professor, Madangeet School of Green Energy Technology, Pondicherry Central University, the Alumni member Prof. Sabu Thomas, Associate Professor (Rtd.) for their enthusiastic participation, suggestions and contributions. I express my heartfelt thanks to the internal expert member Mr Robin Francis, and other internal members Mrs. Sreeja R, Mrs Sheeja V, Dr. Sivakumar C, Mrs.Viji. C, Mrs Sheeba.P.X., Dr. Rekha.S,Dr. Gishamol Mathew, Dr. Wilson K.C, Mrs Mary Linsa K S, Dr. Manoj R, Mr.Prasad K.A, Mr. Sajeev K F for their untiring effort and wholehearted support.

Dr. Zeenath. N A.

Head, Department of Physics

21.02.2022 Maharaja’s College, Ernakulam

II.BOARD OF STUDIES IN PHYSICS (2021-23), MAHARAJA'S COLLEGE

01. Dr. Zeenath N.A. (Chairman)
02. Sri. Robin Francis (Internal Member)
03. Smt. Sreeja R. (Internal Member)
04. Smt. Sheeja V. (Internal Member)
05. Dr. Sivakumar C. (Internal Member)
06. Smt. Viji C. (Internal Member)
07. Smt. Sheeba P.X. (Internal Member)
08. Dr. Rekha S. (Internal Member)
09. Dr. Gishamol Mathew (Internal Member)
10. Dr. Wilson K.C. (Internal Member)
11. Smt. Mary Linsa K.S. (Internal Member)
12. Dr. Manoj R. (Internal Member)
13. Sri. Prasad K.A. (Internal Member)
14. Sri. Sajeev K.F. (Internal Member)
15. Dr. N.Shaji (External Member)
16. Dr. Prasanth R. (External Member)
17. Dr. Sreekumar R. (External Member)
18. Prof. Sabu Thomas (External Member)

III.REGULATIONS OF THE POST GRADUATE PROGRAMMES UNDER CREDIT SEMESTER SYSTEM, 2022 (MC-PGP-CSS2022)

1. SHORT TITLE

1.1. These Regulations shall be called Maharaja's College (Government Autonomous) Regulations(2019) governing Post Graduate Programmes under Credit Semester System (MC-PGP-CSS2022)

1.2. These Regulations shall come into force from the Academic Year 2019-2020.

2. SCOPE

2.1. The regulation provided herein shall apply to all Post- graduate programmes from the academic year 2019-2020 admission.

2.2. The provisions herein supersede all the existing regulations for the regular post-graduate programmes conducted in Maharaja's College unless otherwise specified.

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 (MC-PGP- CSS2022).

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 minimum of 18 such academic weeks constitute a semester.

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

3.3. **CE** means Continuous Evaluation (Internal Evaluation)

3.4. **College Co-ordinator** means a teacher from the college nominated by the College Council to look into the matters relating to MC-PGP-CSS2022 for programmes conducted in the College.

3.5. **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.

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

3.7. **Core course** means a course which cannot be substituted by any other course.

3.8. **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 / viva-voce etc., to meet effective teaching and learning needs.

3.9. **Course Code** means a unique alpha numeric code assigned to each course ofa programme.

3.10. **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 thefinal examination.'

3.11. **Course Teacher** means the teacher of the institution in charge of the course offered in the programme.

3.12. **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.

3.13. **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.

3.14. **Cumulative Grade point average (CGPA)** is the value obtained by dividing the sum of credit points of 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)

3.15. **Department** means any teaching Department in the college.

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

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

3.18. **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.

3.19. **Elective course** means a course, which can be substituted, by an equivalent course from the same subject.

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

3.21. **ESE** means End Semester Evaluation (External Evaluation).

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

3.23. **External Examiner** is the teacher appointed from other colleges for the valuation of courses of study undergone by the students in a College. The external examiner shall be appointed by the University.

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

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

3.26. **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.

3.27. **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 points obtained in the course by the sum of the weights of the Course **(GPA =ΣWGP / ΣMW).**

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

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

3.30. **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.

3.31. MC-PGP-CSS2019 means Maharaja's College (Government Autonomous) Regulations Governing Post Graduate programmes under Credit Semester System, 2019.

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

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

3.34. **Programme** means the entire course of study and examinations.

3.35. **Project** is a core course in a proramme. 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 center 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.

3.36. **Repeat course** is a course that is repeated by a student for having failed in that course in an earlier registration.

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

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

3.39. **Semester Grade Point Average (SGPA)** is the value obtained by dividing the sum of credit points (CP) obtained by a 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 ofa student at the end of a semester **(SGPA = Total CP obtained in the semester / Total Credits for the semester).**

3.40. **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.

3.41. **University** means Mahatma Gandhi University, Kottayam, Kerala.

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

3.43. **Weighted Grade Point (WGP)** is the grade point multiplied by weight.

(WGP = GP xW)

3.44. **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.

3.45. **Internship** means gain a professional work experience

4. ACADEMIC COMMITTEE

4.1. There shall be an Academic Committee constituted by the Principal to manage and monitor the working of MC-PGP-CSS2022.

4.2. The Committee consists of

(a) Principal

(b) Vice-Principal

(c) Secretary, Academic Council

(d) The Controller of Examinations

(e) Two Teachers nominated from among the College Council

4.3. There shall be a subcommittee nominated by the Principal to look after the day-to-day affairs of the Regulations for Post Graduate Programmes under MC-PGP-CSS2022.

5. PROGRAMME STRUCTURE

5.1. Students shall be admitted to post graduate programme under the various 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 / practicals etc.

5.2. No regular student shall register for more than 25 credits and less than 16 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 at least two and not more than four elective groups(Group A, Group B, Group C, etc.) comprising of three courses each for a programme and these elective courses shall be included either in fourth semester or be distributed among third and fourth semesters. This clause is not applicable for programmes defined by the Expert Committees of Music and Performing Arts.

5.3.2. The number of elective courses assigned for study in a particular semester shall be the same across all elective groups for the programme concerned.

5.3.3. The colleges shall select any one of the elective groups for each programme as per the interest of the students, availability of faculty and academic infrastructure in the institution.

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

5.3.5. The elective groups selected by the College 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 by the college for the students who are admitted in a particular academic year 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 college going student shall submit atleast one assignment as an internal component for each course.

5.6. **Seminar Lecture:** Every regular 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 regular student shall undergo at least two class tests as an internal component for each course with a weightage of 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 Principal.

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 MC-PGP-CSS2022 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 has registered for the programme shall complete the programme within a period of four years from the date of commencement of the programme.

8. ADMISSION

8.1. The admission to all regular PG programmes shall be through PG- CAP (Centralized Allotment Process) of the Maharaja's College unless otherwise specified.

8.2. The eligibility criteria for admission to PG Programmes shall be published by the Maharaja's Colleg along with the notification for admission.

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 recognized by 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 a particular 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. There shall be End Semester Examinations at the end of each semester.

11.2. Practical examinations shall be conducted by the College 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 subjected to the approval of the Academic Council of the College.

11.3. End-Semester Examinations: The examinations shall normally be conducted at the end of each semester for regular students.

11.4. There shall be one end-semester examination of 3 hours duration for each lecture based and practical courses.

11.5. 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 12.15.

12.4. **Internal evaluation for Regular programme:** The internal evaluation shall be based on predetermined transparent system involving 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**

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

b) For theory (ESE) External Evaluation is based on the pattern of questions 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 the weightage of the components 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 the weightage of the components of the practical (External) can be modified by the concerned BoS without changing the total weightage 15**)**

e) For Project (CE) Internal

(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**)**

A two stage Internal evaluation to be followed for the fruitful completion of the project.

f) For Project (ECE) 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

Components	Internal (CE) Weight	External (ESE) Weight
Basic knowledge and Presentation skills	1	3

Topic of interest	1	3
Knowledge of core courses	3	9
Total	**5**	**15**

These basic components can be subdivided if necessary. Total as well as component weightage shall not be changed.

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 which shall be forwarded to the University through the Principal 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 University 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 preferably through Centralized Valuation.

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 College/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. Direct Grading System. 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 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

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(pass)
up to 1.99	D	Deficient(Fail)

12.19. No separate minimum is required for internal evaluation for a pass, but a minimum C 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 candidates who wish to improve the grade / grade point of the external examination 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 semesters 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 practicals / 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 points of all courses taken by a student in the 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) = $\Sigma(C_i \times G_i) / \Sigma(C_i$

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

Where 'Sj' is the j semester, 'Gi ' is the grade point scored by the Student in the 'i' course 'q' 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) = $\Sigma((C_i \times S_i) / \Sigma(C_i$ (CGPA= Total credit points awarded in all semesters / Total credits of the programme)

Where 'CI' is the credits for the 'i' semester 'Si' 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 University under its seal shall issue to the students, a consolidated grade card on completion of the programme, which shall contain the following information.

- Name of College
- Title of the PG Programme.
- Name of the Semesters
- Name and Register Number of the student
- Code, Title, Credits and Max GPA (Internal, External & Total) of each course (theory& Practical), project, viva etc. in each semester.
- Internal, external and total grade, Grade Point (G), Letter Grade and Credit Point (P) in each course opted in the semester.
- The total credits and total credit points in each semester.
- Semester Grade Point Average (SGPA) and corresponding Grade in each semester
- Cumulative Grade Point Average (CGPA), Grade for the entire programme.
- Separate Grade card will be issued at the request of candidates and based on University Guidelines issued from time to time.
- Details of description ofevaluation process- Grade and Grade Point as well as indicators, calculation methodology ofSGPA 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 Vice- chancellor to monitor the internal evaluations conducted by institutions.

16. RANK CERTIFICATE

The College shall publish the list of top 10 candidates for each programme after the publication of the programme results. Rank certificate shall be issued to candidates who secure positions from 1st to 3rd in the list. Position certificate shall be issued to candidates on theirrequest.

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/position. Rank certificate and position certificate shall be signed by 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. 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.

19. Credits allotted for Programmes and Courses

19.1 Total credit for each programme shall be 80.

19.2 Semester-wise total credit can vary from 16 to 25

19.3 The minimum credit of a course is 2 and maximum credit is 5.

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

21. Course codes: The course codes assigned for all courses (core courses, elective courses, common courses etc.) shall be unique.

22. Models of distribution of courses, course codes, type of the course, credits, teaching hours for a programme are given in the following tables.

Example: Programmes with practical - Total Credits 80 - Scheme of the Syllabus

Semester	Course-code	Course name	Type of the course	TeachingHours Per Week	Credit	Total Credits
I	Course.code1	Name1	core	4	4	19
	Course.code2	Name2	core	4	4	
	Course.code3	Name3	core	4	4	
	Course.code4	Name4	core	3	3	
	Practical Course.code5	Name5	core	10	4	
II	Course.code6	Name6	core	4	4	20
	Course.code7	Name7	core	4	4	
	Course.code8	Name8	core	4	4	
	Course.code9	Name9	core	3	4	
	Practical-Course.code10	Name10	core	10	4	
III	Course.code11	Name11	core	4	4	20
	Course.code12	Name12	core	4	4	
	Course.code13	Name13	core	4	4	
	Course.code14	Name14	core	3	4	
	Practical Course.code15	Name15	core	10	4	
	Course.code16	Name16	Elective	5	3	
	Course.code17	Name17	Elective	5	3	
	Course.code18	Name18	Elective	5	3	

IV	Practical-Course.code19	Name19	core	10	5	21
	Project-Course.code20	Name20	core		5	
	Comprehensive viva- voce - Course.code 21	Name 21	core		2	
	Total					**80**

Example: Programmes without practical -Total Credits 80- Scheme of the Syllabus

Semester	Course. code	Course. name	Type of the course	Teaching Hours per week	Credit	Total Credits
I	Course.code1	Name1	core	5	4	20
	Course.code2	Name2	core	5	4	
	Course.code3	Name3	core	5	4	
	Course.code4	Name4	core	5	4	
	Course.code5	Name5	core	5	4	
II	Course.code6	Name6	core	5	4	20
	Course.code7	Name7	core	5	4	
	Course.code8	Name8	core	5	4	
	Course.code9	Name9	core	5	4	
	Course.code10	Name10	core	5	4	
III	Course.code11	Name11	core	5	4	20
	Course.code12	Name12	core	5	4	
	Course.code13	Name13	core	5	4	
	Course.code14	Name14	core	5	4	
	Course.code15	Name15	core	5	4	
IV	Course.code16	Name16	Elective	5	3	20
	Course.code17	Name17	Elective	5	3	
	Course.code18	Name18	Elective	5	3	
	Course.code19	Name19	core	5	4	
	Project-Course.code20	Name20	core	5	5	

	Comprehensive viva-voce-Course.code21	Name 21	core		2	
	Total					**80**

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
Upto 1.99	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	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	20	A+	5	5	25
	21	-	-	-	-
	22	-	-	-	-
	23	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. *ie*., maximum 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 weight =17/5=3.40**
Lab involvement & record	1	A+	5	5	
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	2	C	2	4	**WGP/Total weight = 59/15= 3.93**
Project content & presentation	8	A+	5	40	
Project viva-voce	5	B	3	15	
Total	**15**			**59**	**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 1.5. Therefore Maximum Weighted Grade Point (WGP) is 75.

Comprehensive viva voce-Internal-CE

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

Components	Internal (CE) Weight	External (ESE) Weight
Basic knowledge and Presentation skills	1	3
Topic of interest	1	3
Knowledge of core courses	3	9
Total	**5**	**15**

These basic components can be subdivided if necessary

2. Evaluation - second stage -

Consolidation of the Grade(GPA) of a Course PC-I.

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

Semester Grade Point Average (SGPA).

Course code	Title of 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 - fourth Stage -

Cumulative Grade Point Average (CGPA)

If a candidate is awarded three A+ grades in semester 1 (SGPA of semester 1), semester 2 (SGPA of semester 2) and semester 4 (SGPA of semester 4) and a B grade in semester 3 (SGPA of semester 3). Then the 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				

IV.MSc PHYSICS (MRPHYPG) SCHEME

Theory courses

There are sixteen theory courses spread equally in all four semesters in the M.Sc. Programme. Distribution of theory courses is as follows. There are twelve core courses common to all students called programme core courses. Semester I and Semester II will have four core courses each and Semester III and Semester IV will have two core courses each. Two elective courses called programme elective courses, each will come in Semester III and Semester IV. There are two Elective Groups, with each elective Group has four theory courses.

Practical

All four semesters will have a course on laboratory practical. The laboratory practical of Semesters I, II and III are common courses. The Semester IV laboratory practical course will change, subject to the Elective Group opted by the college. A minimum of 10 experiments should be done and recorded in each semester. The practical examinations will be conducted by two external examiners appointed by the college at the end of even semesters only. The first and second semester examinations of laboratory practical courses will be conducted at the end of Semester II while the third and fourth semester practical examinations will be conducted at the end of Semester IV.

Project

The project of the PG program should be very relevant and innovative in nature. The type of project can be decided by the student and the guide (a faculty of the department or other department/college/university/institution). The project work should be taken up seriously by the student and the guide. The project should be aimed to motivate the inquisitive and research aptitude of the students. The students may be encouraged to present the results of the project in seminars/symposia. The conduct of the project may be started at the beginning of Semester III, with its evaluation scheduled at the end of Semester IV along with the practical examination as being practiced in the present syllabus. The project is evaluated by the external examiners. The project guide or a faculty member deputed by the head of the department may be present at the time of project evaluation. This is to facilitate the proper assessment of the project.

1. Project work shall be completed by working outside the regular teaching hours
2. Project work shall be carried out under the supervision of a teacher in the concerned department.
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 Supervisor.
4. There should be an in-semester assessment and end-semester assessment for

the project work.

5. The end-semester evaluation of the Project work is followed by presentation of work including dissertation and Viva-Voce.

Seminars

Every PG student shall deliver one seminar lecture as an internal component for every course. The seminar lecture is expected to train the student in self-study, collection of relevant matter from the books and Internet resources, editing, document writing, typing and presentation.

Test Papers

Every student shall undergo at least two class tests as an internal component for every course. The weighted average shall be taken for awarding the grade for class tests.

Assignments

Every student shall submit one assignment as an internal component for every course.

Attendance

1. The minimum requirement of aggregate attendance during a semester for appearing the end semester examination shall be 75%.

2. Condonation of shortage of attendance to a maximum of 10 days in a semester, once during the whole period of postgraduate programme.

3. If a student represents his/her institution, University, State or Nation in Sports, NCC, NSS or Cultural or any other officially sponsored activities such as college union / university union activities, he/she shall be eligible to claim the attendance for the actual number of days participated subject to a maximum of 10 days in a Semester based on the specific recommendations of the Head of the Department and Principal of the College.

4. A student who does not satisfy the requirements of attendance shall not be permitted to take the end-semester examinations.

Maximum Credits

No course shall have more than 4 credits.

Viva Voce

A viva voce examination will be conducted by the two external examiners at the time of evaluation of the project. The components of viva consist of subject of special interest, fundamental physics, topics covering all semesters and awareness of current and advanced topics with separate marks.

Course Code

The 12 core courses in the programmme are coded according to the following criteria. The first two letters of the code is PG. One digit to indicate the semester. Letters PHY indicate PG in Physics, followed by C to indicate core, lastly digits 01, 02 ..... 12 run for twelve core courses. (E.g.: PG3PHYC11 – PG in Physics, 3rd semester, core course number eleven of the programme).The elective courses are coded in similar pattern, PG3PHYEA02 with letter E stands for Elective, while the letter A (it can be B, C, or D) stands for the Elective Group, the digit 2 stands for the 2nd course of the Elective Group. Laboratory Practical courses are similarly coded. (E.g.: PG2PHYP01 means Physics, II Semester, Practical, course number 1) The course code of project/dissertation is PG4PHYD01. The course code of viva voce is PG4PHYV01. The letters D and V stand for dissertation of the project and viva voce respectively. These codes remain the same for all four categories of electives.

Semester	Tiitle of the course with code	Number of hours per week	Total Credits	Total hours per semester
1	PG1PHYC01: Mathematical Methods in Physics- I	4	4	72
1	PG1PHYC02: Classical Mechanics	4	4	72
1	PG1PHYC03: Electrodynamics	4	4	72
1	PG1PHYC04: Electronics	4	4	72
1	PG1PHYP01:General Physics Practical	9	3	162
2	PG2PHYC05:Mathematical Methods in Physics- II	4	4	72
2	PG2PHYC06: Quantum Mechanics I	4	4	72
2	PG2PHYC07: Statistical Mechanics	4	4	72
2	PG2PHYC08: Solid State Physics	4	4	72
2	PG2PHYP02: Electronics Practical	9	3	162
3	PG3PHYC09:Quantum Mechanics II	4	4	72
3	PG3PHYC10: Computational Physics	4	4	72

3	PG3PHYP03: Computational Physics Practical	9	3	162
4	PG4PHYC11: Atomic and Molecular Spectroscopy	4	4	72
4	PG4PHYC12: Nuclear and Particle Physics	4	4	72
4	PG4PHYD01: Project/Dissertation	0	2	0
4	PG4PHYV01: Seminar and Viva Voce	0	2	0

Elective groups

There are four Electives Groups offered in this PGCSS Programme. Each elective consists of a group of four theory courses and one laboratory course. The first two theory courses of a group are placed in the Semester III, while the last two theory course and the laboratory course go to the Semester IV.

The Electives Groups are named:

1. Group A: Theoretical Physics

Sem.	Title of the course with Code	Number of Hours per week	Total cred its	Total hours per semester
3	PG3PHYEA01- Astrophysics	4	4	72
3	PG3PHEA02- Nonlinear Dynamics and Chaos	4	4	72
4	PG4PHYEA03-Gravitation & Cosmology	4	4	72
4	PG4PHYEA04- Quantum Field Theory	4	4	72
4	PG4PHYEAP01- Special Computational Lab	9	3	162

2. Group B: Applied Physics

Sem.	Title of the course with code	Number of hours per week	Total cred-its	Total hours per semester

3	PG3PHYEB01- Semiconductor device Physics and Micro electronics	4	4	72
3	PG3PHYEB02- Material Science	4	4	72
4	PG4PHYEB03- Photonics	4	4	72
4	PG4PHYEB04- Electronic Communication & DSP	4	4	72
4	PG4PHYEBP01- Applied Physics Lab	9	3	162

Distribution of Credit

The total credit for the programme 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 as follows.

The credit of theory courses is 4 per course, while that of laboratory practical course is 3 per course. The project and viva voce will have a credit of 2 each.

Semester	Courses	Credit	Total Credit
1	4 Theory courses	4 × 4 = 16	16
2	4 Theory courses 2 Practical	4 × 4 = 16 2 × 3 = 6	22
3	4 Theory courses	4 × 4 = 16	16
4	4 Theory courses 2 Practical courses 1 Project	4 × 4 = 16 2 × 3 = 6 1 × 2 =2 1 × 2 =2	26
	Grand Total		80

V.MSc PHYSICS SYLLABUS (2022 ONWARDS)

V.1.PROGRAM SPECIFIC OUTCOMES (PSO)

PSO1: Understand the conceptual basis of matrices, vectors and complex numbers, the advanced mathematical tools like groups and tensors and integral transforms, integral equations and special functions required to learn theoretical physics.

PSO2: Understand the concepts and facts of the electric, magnetic and thermodynamic properties of matter including its nanoscale- behaviour, the principles of photonics, analogue electronics, semi-conductor device physics, digital electronics, electronic communication and DSP and material science and the theoretical basis of classical and quantum mechanics, relativity, electrodynamics, astrophysics, nuclear and particle physics, gravitation and cosmology, non-linear dynamics, statistical mechanics and quantum field theory and apply the knowledge for analysing and solving problems.

PSO3: Understand and apply the concepts of electronics,microprocessors and micro-electronics in the designing of analogue and digital circuits.

PSO4: Understand the fundamentals of Programming and numerical techniques to apply it to solve theoretical problems.

PSO5: Understand, apply and verify the theoretical/empirical concepts and the experimental facts by practical.

V.2.Semester I (Theory courses)- Credits 4, Hrs 72

PG1PHYC01- Mathematical methods in Physics I

COURSE OUTCOMES(CO):

CO1. Understand the concepts and applications of matrices, complex functions, vectors and tensors in the analysis and theoretical conclusions of the problems in physics. **PSO** – PSO1, **CL** - U, Ap, An, **KC** - C

CO2. Understand and appreciate vector spaces as a general theory of the objects like matrices, tensors and complex functions. **PSO** – PSO1, **CL** - U, **KC** - C

CO3. Understand the special functions and integrals required to solve the theoretical problems of physics. **PSO** – PSO1, **CL** - U, Ap, **KC** - C

Module I: Vector and Tensor analysis (18 Hours)

Basics of vector algebra, identities involving scalar and vector products, scalar field and vector field, del operator in Cartesian space, gradient, divergence, curl and Laplacian in Cartesian space, basic identities involving del operator. Vector integration- Stokes' theorem and Gauss' theorem (statement only), Green's theorem from Gauss' theorem, Helmholtz theorem, Types of vector fields, Orthogonal curvilinear system of cordinates- general expressions for gradient, divergence, curl and Laplacian. Tensors- transformation of contravariant and covariant tensors, scalar, vector and higher rank tensors and their transformation, symmetric and antisymmetric tensors, basic tensor operations- addition, direct product, inner product of tensors and contraction.

Books for study: Book [1], Chapter 1

Module II: Matrix Algebra and Linear vector space (20 Hours)

Basics of matrix algebra, powers of a matrix, transpose of a matrix, symmetry and anti-symmetry, inverse of matrix and solution of a set of linear equations using inverse, complex conjugation of a matrix, Hermitian conjugation, Hermitian matrix, orthogonal matrix, rotation of cordinate system and transformation matrix, orthogonal transformation, unitary matrix and unitary transformation, matrix eigenvalue problem, eigenvalues and eigenvectors of Hermitian matrix, commutator of two matrices, simultaneous eigenvectors, diagonalization of the problem of vibration of CO_2 molecule. Vector space- Linearity of vector space, linear independence, basis and dimension, Gram-Schmidt orthogonalization, Linear operator, matrix representation of operators, operator eigenvalue problem, different operators, Hermitian operator, eigenvalues and eigenvectors of Hermitian operator, commutator of two operators, commuting operators

Books for study: Book [1], Chapter 2

Module III: Complex Analysis (18 Hours)

Complex Numbers- Basic Operations with complex numbers, Polar form of a complex number , De-Moivre's theorem and roots of complex numbers. Functions of complex numbers-Mapping, Branch Lines and Riemann surfaces. Derivatives and analytic functions, Cauchy Riemann Conditions, Harmonic functions, Singular points. Complex Integration- Cauchy's Integral theorem, Cauchy's Integral Formula, Cauchy's Integral formula for higher derivatives. Series representation of complex functions-Taylor series and Laurent Series. Integration by method of Residues- Residues and their evaluation-Residue Theorem, Evaluation of real definite integrals.

Books for study: Book [1], Chapter 6

Module IV: Special Functions - I (16 Hours)

The Factorial function, Gamma function and recursion relation, Gamma function of negative numbers, Some important formulas involving Gamma functions, Beta functions, Beta functions in terms of Gamma functions, simple pendulum problem, The error function, The Stirling's formula, Elliptic integrals and functions.

Books for study: Book [2], Chapter 11

Books for study

1. *Mathematical Methods for Physicists: A Concise Introduction*, Tai L. Chow, Cambridge University Press
2. *Mathematical methods in the Physical Sciences*, Mary L. Boas, John Wiley & Sons
3. *Mathematical Methods for Physicists: A Comprehensive Guide*, Arfken and Weber, Academic Press

References

1. *Physical Mathematics*, Kevin Cahill, Cambridge University Press
2. *A Student's Guide to Vectors and Tensors*, Daniel Fleisch, Cambridge University Press
3. *Mathematical Techniques for Engineers and Scientists*, Larry C. Andrews and Ronald L. Philips, SPIE Press

4. *Mathematical Physics: A Modern Introduction to Its Foundations*, Sadri Hassani, Springer
5. *Group Theory in Physics: An Introduction*, J. F. Cornwell, Academic Press

BLUE PRINT

MODULE	PART A	PART B	PART C	TOTAL
I	3	2	1	6
II	3	2	1	6
III	2	2	1	5
IV	2	2	1	5
TOTAL	10	8	4	22

Model Question paper

Mathematical methods in Physics I

Time: 3 hrs   Max.weight: 30

Part A (*Short answer Questions, answer any eight questions, each of weight 1)*

1. State Helmholtz theorem
2. Explain contraction of a tensor. Give an example
3. What are symmetric and antisymmetric matrices?Express a real square matrix as the sum of a symmetric matrix and an antisymmetric matrix
4. What are orthogonal and unitary transformations?
5. Define basis and dimension of space
6. Write down Christoffel symbol of first kind and Christoffel symbol of second kind. How are they related?
7. What is called the modulus and argument of a complex number. Find the modulus of z=1+i.
8. Explain a) Poles b)Removable singularities.
9. State and explain Cauchy's integral theorem.
10. Give the recursion relation for Gamma Function. Hence calculate $\frac{\Gamma(1/4)}{\Gamma(9/4)}$.

Part B (*Short Essay Questions/Problems, answer any six questions, each of weight 2)*

11. State and prove Green's theorem
12. Discuss different types of vector fields and their properties

13. What do you mean by eigenvalues and eigenvectors of a square matrix? Find the eigenvalues and eigenvectors of $\begin{matrix} 5 & 4 \\ 1 & 2 \end{matrix}$
14. What is a Hermitian matrix?Show that eigenvectors belonging to distinct eigenvalues of a Hermitian matrix are orthogonal
15. Show that $\Gamma(1/2) = \pi/2$.
16. Prove Stirling's Formula.
17. Evaluate $\oint \frac{e^z}{z^2+1}\, dz$ over the circular path of radius |z|=2.
18. Evaluate $\int_{-\infty}^{+\infty} \frac{sinmx}{x^2+k^2}\, dx$.

Part C

Long Essay Questions (answer any two questions, each of weight 5)

19. Obtain the general form of gradient, divergence and curl in orthogonal curvilinear system
20. Define inner product in linear vector space. State the properties of inner product. State and prove Cauchy-Schwartz inequality
21. State and prove Residue Theorem. Show that $\int_0^\infty \frac{\sin x}{x} dx = \frac{\Pi}{2}$.
22. Derive Beta Function in terms of Gamma Function

    Evaluate $\int_0^\infty \frac{x^3}{(1+x)^5} dx$

PG1PHYC02- Classical Mechanics

COURSE OUTCOMES(CO):
CO1. To understand the basic formulations- D' Alembert's principle, Lagrangian formalism, Symmetry properties, the theory of small oscillations with examples. **PSO** - PSO2, **CL** -U,An, **KC** - C,P
CO2. To understand the Hamilton equations of motion, canonical transformation, Poisson brackets and H-J theory- H-J equation in terms of Principal function and characteristic function. **PSO** - PSO2, **CL** - U,An, **KC** - C,P
CO3. To understand C-F motion: equations of motion and first integrals, Kepler problem-inverse square law of force. Scattering in a central force field – Rutherford scattering formula. **PSO** - PSO2, **CL** - U,An, **KC** - C,P
CO4. To understand Rigid body dynamics: Independent co-ordinates of a rigid body, orthogonal transformations, Euler's angles, torque free motion of a rigid body.
PSO - PSO2, **CL** - U,An, **KC** - C,P.

Module-I: Lagrangian Formulation (12 hours)

Constraints, Degrees of freedom, Generalized coordinates, Phase space, Principle of virtual work, D' Alembert's principle, Lagrange's equations for a conservative system, Applications- Simple pendulum, Atwood's machine, A bead sliding on a rotating wire, Cyclic coordinates, Conservation theorems and symmetry properties- Homogeneity of space, Isotropy of space, Homogeneity in time- Hamiltonian function.

Books for study: Book [1], Chapter 1 & Book [2], Chapter 3

Mechanics of small oscillations (6 hours)

Equilibrium and potential energy, theory of small oscillations, normal modes, two coupled pendula, longitudinal vibrations of CO_2 molecule - normal frequencies, normal modes, normal co - ordinates.

Books for study: Book [2], Chapter 9

Module II: Hamiltonian Formulation (12 hours)

Hamilton's principle, Techniques of the Calculus of variations- Shortest distance in a plane, Minimum surface of revolution, The Brachistochrone problem, Hamilton's equations of motion from Hamiltonian function.

Equations of canonical transformation, harmonic oscillator. Poisson brackets – fundamental Poisson brackets, fundamental properties. Equations of motion in Poisson bracket form, Poisson bracket and integrals of motion, canonical invariance of Poisson bracket.

Books for study: Book [1]: Chapters 2, 9 & Book [2]: Chapter 6

Hamilton Jacobi Theory (6 hours)

Hamilton Jacobi equation, Hamilton's principal function – physical significances, Hamilton's characteristic function, Harmonic oscillator problem in H - J method. Hamilton Jacobi equation as an approximation to Schroedinger's wave equation.

Books for study: Book [2]: Chapter 7

Module III: Central force problem (14 hours)

Central force, Reduction to equivalent one body problem, equations of motion and first integrals, equivalent one dimensional problem and classification of orbits, Virial theorem, differential equation for the orbit and integrable power law potentials, conditions for closed orbits, Kepler problem - inverse square law of force. Kepler's equation.

Theory of scattering (4 hours):

Scattering cross-section, Impact parameter, Scattering in a central force field – Rutherford scattering formula, transformation of the scattering problem to laboratory co-ordinates.

Book for study: Book [1]: Chapter 3

Module IV: Rigid body dynamics (18 hours)

Degrees of freedom and Independent co-ordinates of a rigid body, orthogonal transformations, properties of transformation matrix, Euler angles, Euler's theorem on the motion of a rigid body, finite rotations and finite rotation formula, infinitesimal rotations, rate of change of a vector, Coriolis force, angular momentum, kinetic energy, inertia tensor, moment of inertia, principal axes, principal axes transformations, principal moment of inertia, Euler's equations of motion, torque free motion of a rigid body, symmetrical top.

Book for study: Book [1]: Chapter 4 and 5

Books for study

1. *Classical Mechanics*, 3rd Edition, Herbert Goldstein, Charles P Poole, John Safko, Addison - Wesley Publishers.
2. *Classical mechanics*, G Aruldhas, PHI Learning, Pvt Ltd.

BLUE PRINT

MODULE	PART A	PART B	PART C	TOTAL
I	3	2	1	6
II	3	2	1	6
III	2	2	1	5
IV	2	2	1	5
TOTAL	10	8	4	22

Model Question paper

Classical Mechanics

Time: 3 hrs Max.weight: 30

Part A (*Short answer Questions, answer any eight questions, each of weight 1)*

1. Explain the principle of virtual work.
2. Prove that the momentum conjugate to a cyclic coordinate is a constant of motion.

3. Explain the stable, unstable and neutral equilibria using potential function.
4. Obtain the equations of motion in Poisson bracket form.
5. State and explain Hamilton's principle.
6. Give the significances of Hamilton's principal function.
7. Write Lagrangian of a partice moving under a central force and hence derive Lagrange's equations of motion of such a particle.
8. For circular and parabolic orbits in an attractive 1/r potential having the same angular momentum, show that the perihelion distance of the parabola is one-half the radius of the circle.
9. What is Coriolis force. Find a formula for it.
10. What you meant by principal axes and principal moments of inertia?

Part B

Short Essay Questions/Problems (answer any six questions, each of weight 2)

11. Discuss the theory of small oscillations.
12. Prove that the isotropy of space leads to the conservation of angular momentum.
13. Solve the Brachistochrone problem using the method of calculus.
14. Prove that the Poisson brackets are invariant under canonical transformation.
15. Reduce a two body central force problem into an equivalent one body problem. Hence explain the concept of reduced mass.
16. State and explain virial theorem. Show that for a central force problem, $T = -\frac{V}{2}$
17. Briefly explain the concept of Euler angles.
18. Prove that angular momentum of a moving rigid body with a fixed point is $L = I\omega$, where further show that I is a second rank symmetric tensor.

Part C

Long Essay Questions (answer any two questions, each of weight 5)

19. Derive the Lagrange's equations of motion for a conservative system.
20. Discuss the canonical transformations of different types.
21. Derive the elliptical orbit equation for a planet moving in a central force which obeys inverse square law force.
22. Derive Euler's equations of motion. Explain the precessional motion of a symmetric top.

PG1PHYC03- Electrodynamics

COURSE OUTCOMES(CO):

CO1. Understand and apply the fundamentals of vector calculus, including gradient, divergence and curl and their fundamental theorems, **PSO**- PSO1, PSO2, **CL**- U, Ap, **KC** - C, P

CO2. Understand the basic properties of electrostatic and magnetostatic fields and apply and analyze electrostatic problems using Laplace equation and method of images. **PSO**- PSO2, **CL**- U,An,Ap, **KC**-C,P

CO3. Understand the properties of time varying electromagnetic fields and Maxwell's contribution to the study of electric and magnetic fields. Also understand the benefits of potential formulation of electrodynamics, energy associated with electromagnetic fields, Maxwell's stress tensor. **PSO**- PSO2, **CL**- U, Ap, **KC**- C,F

CO4. Understand the properties of electromagnetic waves and apply them to the propagation of electromagnetic waves through vacuum, linear dielectric media, reflection from different interfaces and the physical basis of dispersion. **PSO**- PSO2, **CL**- U, Ap, **KC**- C,F

CO5. Understand the covariant formulation of electrodynamics and apply it to physical systems. **PSO**- PSO2, **CL**- U,An, **KC**-C,P

CO6. Understand and analyze the propagation of electomagnetic waves in waveguides. **PSO**- PSO2, **CL**- U,An, **KC**-C,F

CO7. Understand the theoretical concept of radiation from moving charges and physical basis of radiation reaction. **PSO**- PSO2, **CL**- U, **KC**-C

Module-I: Electrostatic Fields and Electrodynamics (20 hours):

Scalar and vector fields -Physical significance of Gradient, divergence and curl, Poisson's and Laplace Equations- Laplace's equation in one, two and three dimensions, Boundary conditions and uniqueness theorems-First Uniqueness theorem- Conductors and the Second uniqueness theorem, Method of images-The classic image problem - point charge above a grounded conducting plane- induced surface charge, Other image problems- Multipole expansion-Approximate potentials at large distances, The monopole and dipole terms, The electric field of a dipole. Magnetostatics, Magnetic field due to Current distributions, Flux theorem and divergence of B, Ampere's law, Curl of B, Time varying fields-Electromotive force - Faraday's law- Boundary conditions of electric and magnetic field.

Books for study: Book [1], Chapters 2,3,4,5,7

Module-II:Electromagnetic waves (16 hours):

Equation of continuity, Maxwell's equations- Electrodynamics before Maxwell, Maxwell's modification of Ampere circuital theorem, Maxwell's equations in free space and matter, Poynting's theorem, Maxwell's stress tensor, Scalar and vector potentials, Gauge transformations. Electromagnetic waves in vacuum-Energy and Momentum in electromagnetic waves. Electromagnetic waves in matter-propagation in linear media, reflection and transmission (normal and oblique incidence). Electromagnetic waves in conductors-Reflection at a conducting surface, Frequency dependence of permittivity.

Books for study: Book [1], Chapters 7,8,9,10

Module-III: Covariant Formulation of Electrodynamics(12 hours) :

Special Theory of relativity, Einstein's postulates, Lorentz Transformations, Structure of Space time, Proper Time and Proper velocity, Relativistic Energy and Momentum, Relativistic Dynamics, Magnetism as a relativistic phenomenon, Lorentz transformation of electromagnetic field, Field tensor, Electrodynamics in tensor notation, Relativistic potentials.

Books for study: Book [1], Chapter12

Wave Guides and Resonant cavities (10 hours):

Waveguides-Rectangular wave guide, Transverse Magnetic Modes, Transverse Electric Modes, Power Attenuation in a wave guide (Qualitative idea), Wave guide resonators

Books for study: Book [3], Chapter10

Module IV: Radiation by moving charges (14 hours)

Retarded potentials, Jefimenkos equations, Point charges, Lienard- Wiechert potential, Fields of a moving point charge, Electric dipole radiation, Magnetic dipole radiation, Power radiated by point charge in motion, Radiation reaction, Physical basis of radiation reaction.

Book for study: Book [1], Chapter11

Books for study

1. *Introduction to Electrodynamics*, 3rd Edition, David J.Griffths,PHI
2. *Principles of Electromagnetics*, 6th Edn., Matthew N.O. Sadiku, S.V. Kulkarni, Oxford university Press
3. *Field and Wave Electromagnetics*, David K. Cheng, Pearson Education

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MODULE	PART A	PART B	PART C	TOTAL

I	**3**	**2**	**1**	**6**
II	**3**	**2**	**1**	**6**
III	**2**	**2**	**1**	**5**
IV	**2**	**2**	**1**	**5**
TOTAL	**10**	**8**	**4**	**22**

Model Question paper

Electrodynamics

Time: 3 hrs   Max.weight: 30

Part A

Short answer Questions (answer any eight questions, each of weight 1)

1. State the fundamental theorem on divergence. Derive the differential form of Gauss's law using it.
2. Derive Laplace equation. What down the solution of Laplace equation in one dimension.
3. What is the curl E for an electrostatic field? How will it change for a time varying field?
4. What is displacement current? Explain why Maxwell modified Ampere's law.
5. Write down the expression for a plane electromagnetic wave in a conductor. What is the skin depth of a conductor?
6. Prove that electromagnetic waves are transvers waves.
7. Find the velocity of a particle at which it kinetic energy becomes twice its rest energy.
8. Differentiate between TE and TM modes in a wave guide.
9. What is Lienard-Wiechert potential?
10. Explain the significance of radiation reaction.

Part B

Short Essay Questions/Problems (answer any six questions, each of weight 2)

11. State and prove the first and second uniqueness theorems in electrostatics and explain their significance.
12. A point charge q is placed at a distance d above a conducting infinite sheet which is grounded. Derive the expression for the density of surface charge and total charge induced on the conducting sheet.

13. Write a note on gauge transformations. Differentiate between Coulomb gauge and Lorentz gauge.
14. State and prove Poynting's theorem.
15. Show that magnetism can be considered as a relative phenomenon.
16. Obtain Lorentz force law in tensor form.
17. Derive Jefimenko's equations and explain their significance.
18. Show that the power radiated by an electric dipole is proportional to fourth power of frequency.

Part C

Long Essay Questions (answer any two questions, each of weight 5)

19. Derive the expression for approximate potential at large distances from a charge distribution using multipole expansion. Also derive the electric field due to an electric dipole.
20. What is Maxwell's stress tensor? Obtain the total electromagnetic force on the charges in a volume using stress tensor.
21. Reformulate Maxwell's equations and Lorentz force law using relativistic tensor notatons.
22. Derive the expression for Lienard-Wiechert potentials for a moving point charge.

PG1PHYC04- Electronics

COURSE OUTCOMES(CO):

CO1. Understand the working of op- amp, its various parameters, differentiate the gain of op-amp with feedback and without feedback ,compare the characteristics of ideal op-amp and practical op-amp. **PSO** - PSO3, **CL**-U, **KC**-F

CO2. Identify the factors responsible for variations in open-loop gain as a function of frequency, analyze the frequency response of internally compensated op- amps and non compensated op- amps , realize the difference between transient response and slew rate, apply their knowledge in general linear applications. **PSO -** PSO3, **CL**-U,Ap, **KC**-F

CO3. Understand the working of active filters,phase shift and wien bridge oscillators, square, triangular and sawtooth wave generators, voltage controlled oscillator,comparators,Schmitt trigger and their applications,design etc. PSO PSO3, **CL**-U,Ap,An,C, **KC**-F,P

CO4. Understand the microarchitecture of 8086,addressing modes,instruction set,assembler directives, basic ideas of 8087 coprocessor.Learn to write basic programmes. **PSO** PSO3, **CL**-U,An, **KC**-C,P

Module-I

Operational Amplifier (5 Hours)

Block diagram representation– Electrical parameters: Input offset voltage, input offset current, input bias current, CMRR, SVRR, output voltage swing, transient response, slew rate, gain bandwidth product – Ideal Op-amp, equivalent circuit, ideal voltage transfer curve – open loop Op-amp configurations

Op-amp with feedback (8 Hours)

Feedback configurations - Voltage seriesfeedback: Negative feedback, closed loop voltage gain, difference input voltage ideally zero – Input and output resistance with feedback, bandwidth with feed- back, total output offset voltage with feedback, voltage follower

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 and two op-amps.

Books for study: Book [1], Chapters 2, 3

The practical Op-amp (5 Hours)

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 - Noise– Common mode configuration and CMRR.

Books for study: Book [1], Chapters 4

Module-II

Frequency response of an Op-amp (9 Hours)

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.

Books for study: Book [1] Chapter 5

General linear applications (9 Hours):

DC and AC amplifiers – AC amplifier with single supply voltage – Peaking amplifier– Summing, Scaling, averaging amplifiers – integrator and differentiator.

Books for study: Book [1] Chapter 6

Module-III:

Active filters and oscillators (14 hours)

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, triangular and saw-tooth wave generators - Voltage controlled oscillator

Comparators and Converters (4 Hours):

Basic comparator - zero crossing detector – Schmitt trigger – Voltage to frequency and frequency to voltage converters

Books for study: Book [1]

Module-IV

The 8086 Microprocessor (18 Hours)

Micro-architecture of 8086 –Software model – Memory address space and data organization – Segment registers and memory segmentation – Dedicated, reserved and general use memory – Instruction pointer – Data registers– Pointer and Index registers – Status registers– Generating memory address– The Stack – Input/ Output address space

Books for study: Book [2]

Addressing modes - Instruction set – Assembler Directives – Basic programming: Addition of two 16 bit numbers, Largest and smallest numbers in an array, sorting in the ascending and descending order

Books for study: Book [2] and [3]

Books for study

1. *Op–amps and linear integrated circuits*, R.A. Gayakwad 4th Edn., PHI.
2. *The 8088 and 8086 Microprocessors: Programming, Interfacing, Software,Hardware and Applications*, Walter A. Triebel, Avtar Singh, Pearson.
3. *Microprocessors and microcomputer-based system design*, Second Edition,Mohammed Rafiquzzaman, CRC Press.
4. *Microprocessor 8086 programming and Interfacing*, A. Nagoor Kani, RBAPublications.

BLUE PRINT

MODULE	PART A	PART B	PART C	TOTAL
I	3	2	1	6
II	3	2	1	6
III	2	2	1	5
IV	2	2	1	5
TOTAL	10	8	4	22

Model Question paper

Electronics

Time: 3 hrs Max.weight: 30

Part A (*Short answer Questions, answer any eight questions, each of weight 1)*

1. Write any three characteristics of an ideal op-amp?
2. Explain why open-loop configurations are not used in linear applications.
3. Negative feedback is also known as a degenerative feedback. Why?
4. Convert the CMRR 90dB value into its equivalent numerical Value.
5. Define break frequency and band width.
6. Write about peaking amplifier?
7. Write the advantages of active filters over passive filters
8. Explain the Butterworth response.
9. Mention the use of queue register in 8086.
10. Explain the assembler directives: ORG, EVEN,EQU and PROC

Part B

Short Essay Questions/Problems (answer any six questions, each of weight 2)

11. What is the offset minimizing resistor R_{OM}? Why is R_{OM} is not need in differential op-amp circuits?
12. Explain the difference between compensated and non compensated networks.
13. What is the slew rate? List the causes of the slew rate and explain its significance in applications.
14. The 741C having the following parameters is connected as a non-inverting amplifier with $R_1 = 1\ k\Omega \quad R_F = 10\ k\Omega. \quad R_i = 2M\Omega \quad A = 200{,}000\ R_o = 75\Omega\ \ f_o \cong 5\ Hz\ Supply\ voltages = \ \pm 15V\ Output\ Voltage\ swing = \pm 13\ V$ Compute the values of $A_F, R_{if}, R_{OF}, f_F\ and\ V_{OOT}$.
15. Explain how a triangular wave generator can be realized using Op-amps. Obtain an expression for the output voltage and sketch the output waveforms.
16. Explain the working of a second order low pass and high pass Butterworth filter with the help of circuit diagram.
17. Explain how memory address is generated in 8086.
18. Give the algorithm/ flowchart and write a program using assembler directives to add two 16 bit numbers using 8086 microprocessor.

Part C

Long Essay Questions (answer any two questions, each of weight 5)

19. Discuss (a) the four negative feedback configurations (b) the effect of negative feedback on inverting and non-inverting amplifiers.
20. (a) Define CMRR and explain the significance of relatively large value of CMRR (b) What is electrical noise? What precautions has to be taken to minimize the effect of noise in an Op-amp circuit?
21. Explain (a) the working of a VCO. What are its applications? (b) V/F and F/V converters
22. Explain the architecture of 8086 Microprocessor.

V.3.Semester II (Theory Courses)- Credits 4, Hrs 72

PG2PHYC05- Mathematical methods in Physics II

COURSE OUTCOMES(CO):

CO1. Understand the concept of special functions and apply it to specific problems. **PSO** PSO1, **CL**-U, **KC**-C

CO2. Understand and appreciate integral transforms and its applications. **PSO** PSO1, **CL**- U, Ap, **KC**-C

CO3. Understand and appreciate partial differential equations and integral equations and their applications in the problems of physics. **PSO** PSO1, **CL**-U, Ap, **KC**-C, P

CO4. Understand the concept of groups and its properties. **PSO** PSO1, **CL**-U, **KC**-C

Module I

Special Functions - II (18 Hours)

Legendre's equation - Rodrigue's formula, generating function, and orthogonality; Associated Legendre functions and their orthogonality; Hermite's equation - Rodrigue's formula, recurrence relations generating function, and orthogonality; Bessel's equation, Rodrigue's formula, generating function, and orthogonality; generating function, recurrence formulas, orthogonality.

Books for study: Book [1], Chapter 7

Module II:

Integral Transforms(18 Hours)

Integral transform and kernel, Fourier transform, condition for existence of Fourier transform, Fourier integral, Fourier sine and cosine transforms, Fourier transform of Gaussian, Fourier transform of rectangular function, Fourier transform of finite wave train, properties of Fourier transform, Fourier integral and Dirac delta function, Parseval's identity and its application in integration. Laplace transform and the condition for its existence, Laplace transform of elementary functions, properties of Laplace transforms, Laplace transforms of unit step function and period function, Laplace transform of derivatives, Laplace transform of functions defined by integral.

Books for study: Book [1], Chapter 4 & 9

Module III

Partial differential equations and Integral equations (18 Hours)

Linear homogeneous second order partial differential equations, separation of Laplace equation in Cartesian, cylindrical polar and spherical polar systems, separation and solution of wave equation, non-homogeneous partial differential equations, non-homogeneous boundary value problems, Green's function and solution of Poisson equation. Integral equations and their classification, derivation of Abel's equation, solution of integral equation- separable kernel method, Neumann series method, Laplace transform method, Fourier transform method, conversion of differential equation into integral equation, classical oscillator, quantum oscillator

Books for study: Book [1], Chapter 9 & 10

Module IV

Group theory (18 Hours)

Definition of a group; Cyclic groups; Group multiplication table; Isomorphic groups; Group permutations, Subgroups and cosets; Con-jugate classes and invariant subgroups; Group representations; Some special groups, the symmetry group D2, D3; U(1); SO(2) and SO(3); SU(n) groups; Homogeneous Lorentz group.

Books for study: Book [1], Chapter 11

Books for study

1. *Mathematical Methods for Physicists*: *A Concise Introduction*, Tai L. Chow, Cambridge University Press
2. *Mathematical methods in the Physical Sciences*, Mary L. Boas, John Wiley & Sons
3. *Mathematical Methods for Physicists: A Comprehensive Guide*, Arfken and Weber, Academic Press

Reference Books

1. *Physical Mathematics*, Kevin Cahill, Cambridge University Press
2. *A Student's Guide to Vectors and Tensors*, Daniel Fleisch, Cambridge University Press
3. *Mathematical Techniques for Engineers and Scientists*, Larry C. Andrews and Ronald L. Philips, SPIE Press
4. *Mathematical Physics: A Modern Introduction to Its Foundations*, Sadri Hassani, Springer
5. *Group Theory in Physics: An Introduction*, J. F. Cornwell, Academic Press

BLUE PRINT

MODULE	PART A	PART B	PART C	TOTAL
I	3	2	1	6
II	3	2	1	6

III	**2**	**2**	**1**	**5**
IV	**2**	**2**	**1**	**5**
TOTAL	**10**	**8**	**4**	**22**

Model Question paper:

Mathematical methods in Physics II

Time: 3 hrs Max.weight: 30

Part A

Short answer Questions (answer any eight questions, each of weight 1)

1. What is meant by Fourier transform of a function?
2. What is Abel's equation?
3. Write down Laplacian in cylindrical and spherical polar systems
4. Show that Laplace transform of x^n is $n!/p^{n+1}$
5. What is it meant by Fourier convolution of two functions?
6. Write the Rodrigues formula and generating function for the Legendre polynomial $P_n(x)$. Also give the plot of $P_2(x)$.
7. Find the Hermite Polynoimial $H_1(x)$ and $H_2(x)$ using the Rodrigues formula for $H_n(x)$.
8. If n is a positive integer , show that the two solutions of Bessel equation are linearly independent $J_{-n}(x)=(-1)^nJ_n(x)$.
9. What is a group? Show that the set of integers do not form a group under multiplication.
10. Write down Green's function for the problem of electrostatic potential.

Part B

Short Essay Questions/Problems (answer any six questions, each of weight 2)

11. Prove that Fourier transform of Gaussian is Gaussian
12. State and prove convolution theorem in Laplace transform
13. Explain the method of separation of variables
14. How is a non-homogeneous partial differential equation solved using Green's function
15. Obtain the orthogonality relation of legendre Polynomial in the interval (0,α).
16. What are called Lie group? Show that the group whose elements are characterized by continuous rotation in the complex plane over the range [0,2Π] forms a Lie group.

17. Show that $H_{n+2}(x)=2x\ H_{n+1}(x) - 2(n+1)H_n(x)$ where $H_n(x)$ is the Hermite Polynomial.
18. Write down the elements and multiplication table of the symmetry group D_2 , a dihedral group with two fold symmetry axis. Check whether the group is Abelian or not.

Part C

Long Essay Questions (answer any two questions, each of weight 5)

19. Find the Fourier transform of rectangular function. Discuss Heisenberg's uncertainty relation in the light of the transform
20. Discuss the different methods of solution of integral equations
21. Describe the orthogonal groups SO(2) and SO(3). Obtain the general elements of these groups. Also find the generator of SO(2) and SO(3).
22. Solve Bessel's differential equation $x^2y'' + xy' + (x^2 - n^2)y = 0$ in the neighbourhood of the point x=0 and n= constant.

PG2PHYC06- Quantum Mechanics I

COURSE OUTCOMES(CO):

CO1. To understand the fundamental concepts of quantum mechanics like quantum mechanical state, linear vector spaces, Hilbert space, Dirac's notation, fundamental postulates of quantum mechanics, translation in space and momentum operators, fundamental commutation relations **PSO**-PSO2, **CL**-U,An, **KC**-C,P

CO2. To understand the admissibility conditions on wave function, the probability interpretation, conservation of probability, and box normalization. **PSO**-PSO2, **CL**-U,An,Ap **KC**-C,P

CO3. Understand and apply the theory of angular momentum , Pauli two component. formalism, rotations in the two component formalism, eigen values and eigen states of angular momentum, orbital angular momentum, addition of two angular momenta – Clebsch - Gordan coefficients. **PSO**-PSO2, **CL**-U,An, **KC**-C,P

CO4. Understand various approximation methods in QM to solve non-exactly solvable problems, like Perturbation theory for stationary states –Variational method – WKB approximation and apply to physical problems. **PSO**-PSO2, **CL**-U,An,Ap, **KC**-C,P

Module I (18 Hours)

Fundamental concepts:

Sequential Stern Gerlach experiments, quantum mechanical state of a system, linear vector spaces, Hilbert space, ket and bra, inner product, ortho-normality, operators, outer product, Hermitian adjoint operator, eigen values and eigen kets of an operator, eigen kets as base kets, completeness relation, projection operator, inverse and unitary operators.

The fundamental postulates of quantum mechanics, measurements, compatible and incompatible observables, expectation value, commutator algebra, uncertainty relation.

Matrix representation of ket, bra and operators, change of basis and unitary transformations, eigen value problem - diagonalization. Representation in continuous basis, position eigenkets and position measurements, translation in space, momentum as generator of translation, fundamental commutation relations.

Books for study: Book 1, Chapter 1; Book 2, Chapter 3

Physical interpretations and conditions on wave function:

Admissibility conditions on wave function, probability interpretation, conservation of probability, box normalization

Book for study: Book 3, Chapter 2

Module II (18 Hours)

Wave functions in position and momentum space

Position space wave function, momentum operator in position basis, momentum space wave function, connecting the position and momentum representations, illustration using Gaussian wave packets.

Book for study: Book 1, Chapter 1

Evolution in time

Time evolution operator and its properties, Schrodinger equation for the time evolution operator, energy eigenkets, time dependence of expectation values, Correlation amplitude and energy-time uncertainty relation, Schrodinger picture and Heisenberg picture, behavior of state kets and observables in both pictures, Heisenberg equation of motion, Ehrenfest’s theorem, SHO - energy eigenkets and eigen values.

Book for study: Book 1, Chapter 2

Identical particles

System of identical particles, symmetric and anti-symmetric wave functions, spins and statistics, Pauli's exclusion principle, Helium atom– symmetry of wave function and energy states.

Book for study: Book 2, Chapter 9

Module III (18 Hours)

Angular momentum

Theory of angular momentum –Infinitesimal rotations and angular momentum commutation relations, rotation operator for spin 1/2 system, Pauli two component formalism, Pauli spin matrices, rotations in the two component formalism, eigen values and eigen states of angular momentum, Commutation relation and ladder operators, Eigen values of J^2 and J_z, matrix elements of angular momentum operators, Representation of rotation operator, orbital angular momentum, spherical harmonics, addition of two angular momenta, simple examples of angular momenta addition, Formal theory of angular momentum addition- Clebsch- Gordan coefficients, calculation of Clebsch-Gordan coefficients for $j_1=j_2=1/2$

Book for study: Book 1, Chapter 3

Module IV (18 Hours)

Exactly solvable Eigen value problem

Motion in a central potential-Hydrogen atom – solution of the radial equation, energy levels, stationary state wave functions, bound states.

Book for study: Book 3, Chapter 4

Approximation methods for stationary states

Perturbation theory for stationary states, equations of various orders of perturbation– non degenerate case – anharmonic oscillator, Degenerate case, Effect of electric field on the energy levels of H atom (Stark effect), Zeeman effect

Variational method – upper bound on ground state energy, Application to excited states, Trial function linear in variational parameters. WKB approximation – WKB wave function, validity of the approximation. Connection formulae (Qualitative)

Books for study: Book 3, Chapter 5

Books for study

1. *Modern Quantum Mechanics*, 2nd Edition: J J Sakkurai, Pearson.
2. *Quantum Mechanics*: V K Thankappan (2003), New age International.
3. *A Text Book of Quantum Mechanics*: P M Mathews and K Venkatesan, Tata McGraw Hill.

Reference

1. *Quantum Mechanics*: G Aruldhas, Prentice Hall of India.
2. *Introductory Quantum Mechanics*: Richard L Liboff, Pearson Education.
3. *Introduction to Quantum Mechanics*: D.J. Grifith, Pearson Education.
4. *Quantum Mechanics: An Introduction*: Walter Greiner and Allan Bromley, Springer.
5. *The Feynman Lectures on Physics Vol3*, Narosa.
6. https://nptel.ac.in/courses/122/106/122106034/
7. https://nptel.ac.in/courses/115106066/

BLUE PRINT

MODULE	PART A	PART B	PART C	TOTAL
I	3	2	1	6
II	3	2	1	6
III	2	2	1	5
IV	2	2	1	5
TOTAL	10	8	4	22

Model Question paper

Quantum Mechanics I

Time: 3 hrs Max.weight: 30

Part A

Short answer Questions (answer any eight questions, each of weight 1)

1. If $|a, b>$ is a simultaneous eigenket of two operators **A** and **B** show that [**A** , **B**] = 0
2. Show that linear momentum operator is the generator of translation.
3. Derive an expression for the momentum operator in position basis.
4. Write a note on the wavefunction of a system of identical particles.
5. What are raising and lowering operators? Explain.
6. Express the orbital angular momentum operators L^2 and L_z as differential operators in position space
7. What are Clebsch-Gordan coefficients?
8. Write a note on Pauli spin matrices.
9. Discuss the essential features of variational method.
10. When can WKB approximation be applied?

Part B

Short Essay Questions/Problems (answer any six questions, each of weight 2)

11. Discuss the matrix representation of ket and bra operators.
12. Show that the trace of an operator is independent of representation.
13. Obtain Ehrenfest theorem for a free particle.
14. Derive the Heisenberg equation of motion for an observable.
15. Obtain the commutation relation $[J^2, J_i] = 0$
16. If **a** is a real vector and σ_i are Pauli matrices show that $(\sigma_i.\mathbf{a})^2 = |a|^2$.
17. Find the ground state energy of an anharmonic oscillator(having x^4 term) using time independent perturbation theory.
18. Explain the lifting of degeneracy in the context of Stark effect.

Part C

Long Essay Questions (answer any two questions, each of weight 5)

19. State and prove Heisenberg's uncertainty relation in quantum mechanics.
20. Give a comparative study of Schrodinger picture and Heisenberg picture of quantum mechanics.
21. Obtain the basic commutation relations for angular momentum operators. Deduce the eigen values of J^2 and J_z.
22. Discuss the motion in a central potential and deduce the energy levels of H atoms

PG2PHYC07- Statistical Mechanics

COURSE OUTCOMES(CO):

CO1. Understand the statistical basis of thermodynamics.**PSO**-PSO2, **CL**-U, **KC**-C

CO2. Understand and apply microcanonical, canonical and grand canonical ensemble theory to different physical systems. **PSO**-PSO2, **CL**-U,Ap, **KC**-C,P

CO3. Understand apply ensemble theory to simple gases with and without internal motion. **PSO**-PSO2, **CL**-U,Ap, **KC**-C

CO4. Understand and apply quantum mechanical ensemble theory using density matrix to various systems . **PSO**-PSO2, **CL**-U,Ap, **KC**-C,P

CO5. Understand the behavior of Bose gas and apply Bose-Einstein Statistics to black body radiation. **PSO**-PSO2, **CL**-U,Ap, **KC**-C,P

CO6. Understand the behavior of Fermi gas and apply Fermi-Dirac Statistics to Pauli paramagnetism and white dwarfs. **PSO**-PSO2, **CL**-U,Ap, **KC**-C,P

CO7. Understand the phenomenon of phase transition and Ising model of phase transition. **PSO**-PSO2, **CL**-U, **KC**-C.

Module I: The Statistical Basis of Thermodynamics (10 Hours)

The macroscopic and microscopic states - Contact between statistics and thermodynamics - Further contact between statistics and thermodynamics - The classical ideal gas - The entropy of mixing and the Gibbs paradox – The correct enumeration of the microstates - Phase space of a classical system - Liouville's theorem and its consequences -The microcanonical ensemble - Example- classical ideal gas- Quantum states and the phase space.

Book for study: Book 1, Chapter 1, 2

The Canonical Ensemble (10 Hours)

Equilibrium between system and a heat reservoir -A system in the canonical ensemble - Physical significance of the various statistical quantities in the canonical ensemble - Alternative expressions for the partition function- The classical systems - Energy fluctuations in the canonical ensemble: Correspondence with the microcanonical ensemble - Equipartition and the virial theorems - A system of harmonic oscillators (classical treatment only)

Book for study: Book 1, Chapter 3

Module II

Grand Canonical Ensemble (8 Hours)

Equilibrium between a system and particle-energy reservoir - A system in the grand canonical ensemble- Physical significance of the various statistical quantities- Density and energy fluctuations in grand canonical ensemble: correspondence with other ensembles.

Book for study: Book 1, Chapter 4

Phase Transitions (10 Hours)

General remarks on the problem of condensation - Condensation of a Van der Waals gas -A dynamical model of phase transitions - Ising model in one dimension- The lattice gas and binary alloy - The critical exponents - Landau's phenomenological theory.

Book for study: Book 1, Chapter 12

Module III

Formulation of Quantum Statistics (9 Hours)

Quantum mechanical ensemble theory: the density matrix - Statistics of various ensembles: The microcanonical ensemble, The canonical ensemble, The grand canonical ensemble - Examples: An electron in magnetic field, a free particle in a box, harmonic oscillator - Systems composed of indistinguishable particles.

Book for study: Book 1, Chapter 5

The theory of simple gases (8 Hours)

An ideal gas in quantum mechanical microcanonical ensemble - An ideal gas in quantum mechanical canonical and grand canonical ensembles - statistics of the occupation numbers - kinetic considerations.

Book for study: Book 1, Chapter 6

Module IV

Ideal Bose systems (10 Hours)

Thermodynamic behavior of an ideal Bose gas - Bose-Einstein condensation – Condition for the onset of Bose-Einstein condensation - Adiabats and isotherms of ideal Bose gas- Thermodynamics of the black body radiation – Expression for the equilibrium number of photons in a radiation cavity.

Book for study: Book 1, Chapter 7

Ideal Fermi Systems (7 Hours):

Thermodynamic behavior of an ideal Fermi gas – Fermi temperature - Magnetic behavior of an ideal Fermi gas - Pauli paramagnetism - Statistical equilibrium of white dwarf stars- Correspondence between mass and radius of white dwarf stars – Chandrasekhar limit.

Book for study: Book 1, Chapter 8

Book for study

1. Statistical Mechanics, Third edition, R. K. Pathria & Paul D. Beale., Academic Press, Indian Edition

Reference Books

1. Fundamentals of statistical and thermal physics, Frederick Reif, McGrawHill book Company
2. Statistical Mechanics, Kerson Huang, Wiley- Indian edition

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MODULE	PART A	PART B	PART C	TOTAL
I	3	2	1	6
II	3	2	1	6
III	2	2	1	5
IV	2	2	1	5
TOTAL	10	8	4	22

Model Question paper

Statistical Mechanics

Time: 3 hrs Max.weight: 30

Part A

Short answer Questions (answer any eight questions, each of weight 1)

1. What is Gibbs paradox? Explain.
2. Define partition function. Write down the Partition function for a classical system.
3. State Virial theorem. Using Virial theorem arrive at the equation for an ideal gas.
4. Express the thermodynamic quantities like pressure, internal energy , Gibbs free energy and entropy in terms of grand partition function.
5. What is the physical significance of q potential in grand canonical ensemble? How does it relate the thermodynamics of a given system and statistics of the corresponding grand canonical ensemble?
6. What is meant by critical exponents?
7. Define density matrix. Write down the density matrix for a microcanonical ensemble.
8. What is thermal wavelength. Explain its significance.
9. Derive the expression for pressure of an ideal Bose gas in terms of internal energy and volume.
10. What is Pauli paramagnetism? Explain.

Part B

Short Essay Questions/Problems (answer any six questions, each of weight 2)

11. State and explain Liouville's theorem.
12. Prove that the measure of energy fluctuation is given by $\frac{(kT^2C_v)^{\frac{1}{2}}}{U}$.
13. Briefly discuss Landau's theory
14. Write a short note on phase transition and critical temperature.
15. Obtain the partition function and heat capacity of a a rigid lattice of spin half atoms in a magnetic field..
16. Deduce the general expression for thermodynamic pressure of ideal gas in quantum mechanical microcanonical ensemble .
17. Derive Planck's law of radiation. Show that Rayleigh's law can be deduced from Planck's law.
18. What are white dwarfs? Discuss the mass-radius relationship and the idea of Chandrasekhar limit.

Part C

Long Essay Questions (answer any two questions, each of weight 5)

19. Derive the thermodynamic properties of a system of harmonic oscillators.
20. Decribe the one dimensional Ising model.
21. Deduce the general expression for the q potential for both classical and quantum mechanical particles in terms of fugacity and obtain the expression for mean occupation number.

22. Explain Bose Einstein condensation and deduce the conditions for the onset of BE condensation..

PG2PHYC08- Solid State Physics

COURSE OUTCOMES(CO):

CO1. Recall the fundaments of crystal lattices, understand the classification of crystal systems and construction of reciprocal lattices, identify the classical and quatum free electron theory and the related applications. **PSO** - PSO2, **CL**-U, Ap, An, **KC**-C,P

CO2. Identify and differentiate the band theory of metals and semiconductors, apply the same in explaining the different physical properties of metals and semiconductors. **PSO** - PSO2, **CL**-U,Ap,An, **KC**-C,F.

CO3. Understand the heat transmissions in crystals based on theoretical foundations of phonons and lattice vibrations, differentiate the theories of the same. **PSO** -PSO2, **CL**-U,Ap,An, **KC**-C.

CO4. Applly the basic knowledge of quantum theory in magnetism and super conductivity. **PSO** - PSO2, **CL**-U,Ap,An, **KC**-C.

Module-I

Elements of crystal structure and free electron theory (18Hours)

Review of crystal lattice fundamentals, Bragg's law, interpretation of Bragg's law, Ewald construction, reciprocal lattice, properties of reciprocal lattice, reciprocal lattice of BCC and FCC.

Books for study: Book [1], Chapter 2

Review of Classical theory: Features of metallic state, Classical Free electron theory- Drude Model, Lorentz model, The failures of the classical model

Books for study: Book 2, Chapter 3

Free electron Fermi Gas: Energy levels and density of orbitals in one dimension, Effect of temperature on Fermi Dirac distribution function, Free electron gas in three dimensions, Heat capacity of the electron gas, Electrical conductivity and Ohm's law, Thermal conductivity of metals

Books for study: Book [1], Chapter 7

Module II

Band Theory of Solids (20 Hours)

The Band theory of Metals: Introduction, Bloch theorem, The Kronig-Penny model, The motion of electron in one dimension according to the band theory, The distinction between metals, insulators and intrinsic semiconductors, The concept of a hole, Brillouin zones, density of states, overlapping of energy bands

Books for study: Book [3], Chapter 10

The band theory of Semiconductors: Introduction, intrinsic semiconductors, extrinsic semiconductors- effect of temperature on extrinsic semiconductors, effective mass of the electron, variation of m* with k, Compound semiconductors, Direct and indirect semiconductors, Drift velocity, mobility and conductivity of intrinsic semiconductors- temperature dependence of mobility, Electron concentration of intrinsic semiconductor in the valence band, concentration of holes of intrinsic semiconductor in the valence band, Fermi level, Electrical conductivity of intrinsic semiconductors, band gap, Law of mass action, Carrier concentration in n-type semiconductors, Carrier concentration in p-type semiconductor, Charge neutrality equation, Carrier transport in semiconductors, Theory of generation and recombination of charge carriers, Hall effect

Books for study: Book [4], Chapter 9

Module III Lattice Dynamics (16 Hours)

Phonons and Lattice Vibrations: Quantization of lattice vibrations, Phonon momentum, Inelastic scattering of photons by long wavelength phonons, Vibrations of monoatomic lattices, Lattice with two atoms per primitive cell

The specific heat at constant volume and constant pressure, Classical theory of heat capacity, Einstein’s theory of specificheat, Debye’s theory of specific heat, Debye approximation, Comparison between Einstein‘s equation and Debye’s equation.

Books for study: Book [4], Chapter 6

Module IV

Magnetism and Superconductivity (18 Hours)

Review of basic terms and relations, Quantum theory of paramagnetism - cooling by adiabatic demagnetization – Hund's rule – ferromagnetism - spontaneous magnetization in ferromagnetic materials - Weiss molecular field - Curie- Weiss law- spontaneous magnetism - internal field and exchange interaction – magnetization curve -saturation magnetization - domain model. Ferrimagnetism and Antiferromagnetism- Neel's temperature

Books for study: Book [3], Chapter 9

Superconductivity: Review of discovery and various properties of superconductors, London Equation - BCS theory of Superconductivity-BCS ground States - Persistent currents-single particle tunneling - Type II Superconductors, Flux quantization in Superconducting ring, Josephson superconductor tunneling effects-DC Josephson effect- ac Josephson effect, Macroscopic quantum interference

Book for study: Book [1], Chapter 12

Books for study

1. *Introduction to Solid State Physics*, 8th Edition, C. Kittel, Wiley.
2. *Solid State Physics*, 2nd Edition, J. S. Blakemore, Cambridge
3. *Solid State Physics*, A.J. Dekker, Mcmillan
4. *Essentials of Solid State Physics* (2013), S. P. Kuila, New central bookagency

Books for reference

1. *Solid State Physics: Structure and properties of materials*, 2nd Edition, M.A. Wahab, Narosa
2. *Solid state physics*, Ashcroft/Mermin, Cengage agency

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MODULE	PART A	PART B	PART C	TOTAL
I	3	2	1	6
II	3	2	1	6
III	2	2	1	5

IV	**2**	**2**	**1**	**5**
TOTAL	**10**	**8**	**4**	**22**

Model Question paper

Solid State Physics

Time: 3 hrs Max.weight: 30

Part A (*Short answer Questions, answer any eight questions, each of weight 1)*

1. Visible light cannot be used to diffract crystals. Justify
2. Define reciprocal lattice.
3. Write the failures of the Drude -Lorentz free electron theory.
4. Represent schematically the classification of solids into metals, semiconductors and insulators using band theory.
5. Define density of states?
6. Define effective mass of an electron? Explain its significance.
7. Differentiate direct and indirect semiconductors?
8. What is a phonon? Give an evidence for the existence of phonon.
9. Explain the domains in ferromagnetic material?
10. Explain Miessner effect.

Part B

Short Essay Questions/Problems (answer any six questions, each of weight 2)

11. Prove that the reciprocal lattice of bcc is fcc and vice versa.
12. The atomic radius of sodium is 1.86 A^o. Calculate the Fermi energy of sodium at absolute zero.
13. What do you mean by effective mass of an electron? Represent the variation of energy and effective mass with wave vector?
14. The electron and hole motilities of Si sample are 0.135 and 0.048 $m^2/V/s$ respectively Determine the conductivity of intrinsic Si at 300 K if the intrinsic carrier concentration is $1.5x10^{16}$ atoms/m^3. The sample is then doped with 10^{23}atoms/m^3 of phosphorous. Determine the equilibrium hole concentration, conductivity and position of the Fermi level relative to the intrinsic level.
15. Show that for one dimensional monoatomic lattice, the phase velocity is equal to the group velocity at low frequencies?
16. Bring out the limitations of einstein's model for specific heat of solids.
17. Discuss the phenomenon of antiferromagnetism ? How does a antiferromagnetic substance differ from a diamagnetic substance?

18. How does the energy gap in superconductor differ from the energy gap in insulator? How does it vary with temperature of superconductor?

Part C

Long Essay Questions (answer any two questions, each of weight 5)

19. Obtain expressions for the Fermi energy, the total energy and the density of states for a free electron gas in one dimension. Show the variation of density of states with energy
20. Discuss the formation of allowed and forbidden energy bands on the basis of the Kronig -Penny model. Discuss the extreme conditions when the energy levels are either discrete or continuous. What is the effect of changing the binding energy of electron on the energy bands?
21. Discuss the Debye model of the lattice heat capacity? What is Debye T^3 law?
22. Give a qualitative description of the BCS theory? How does it account for the superconducting state?

V.4.Semester III (Theory Courses)- Credits 4, Hrs 72

Common Courses

PG3PHYC09 Quantum Mechanics II

COURSE OUTCOMES(CO):

CO1. Understand time dependent perturbation theory and apply it to calculate transition probability in systems with constant, harmonic or other types of perturbations. **PSO** - PSO2, **CL** - U,Ap, **KC** - C,P

CO2. Understand electric dipole approximation, sudden approximation and adiabatic approximation and apply them to physical systems. **PSO** - PSO2, **CL**-U,Ap, **KC**-C

CO3. Understand scattering phenomena and apply it to calculate scattering cross section in high energy and low energy scattering problems using Born approximation and partial wave analysis respectively. **PSO** - PSO2, **CL** - U,Ap, **KC** - C,P

CO4. Understand relativistic quantum mechanics using Klein Gordon equation and Dirac equation,their probability conservation and covariant forms, occurrence of negative energy states, plane wave solutions, approximate Dirac Hamiltonians for electrostatic problems and bilinear covariants . **PSO** - PSO2, **CL**-U, Ap, **KC**-C

CO5. Understand the basics of quantum field theory, Quantization of Klein Gordon field and Dirac Field. **PSO** - PSO2, **CL** - U, **KC** - C

Module I

Time dependent perturbation theory (18 Hours)

Time dependent potentials-interaction picture – time evolution operator in interaction picture-time dependent perturbation theory – Dyson series -transition probability -constant perturbation Fermi-Golden rule – harmonic perturbation – interaction with classical radiation field- absorption and stimulated emission -electric dipole approximation -photo electric effect- energy shift and decay width – sudden and adiabatic approximation.

Books for study: Text Books Books 1 and 3.

Module II

Scattering (18 Hours)

Differential cross section-Asymptotic wave function (Green function method)-Scattering amplitude- Born approximation, Validity of Born approximation- Partial wave analysis -Scattering amplitude in terms of phase shifts, Optical theorem -Low energy scattering, Resonances, Ramsauer-Townsend effect

Books for study: Text Book 4

Module III

Relativistic Quantum Mechanics (18 Hours)

Klein-Gordon equation – Probability conservation – Dirac equation for free particle -Dirac matrices- Conserved current – Dirac gamma matrices - Representation independence- Covariant form and Lorentz covariance of Dirac Equation- Plane wave solutions of Dirac equation-large and small components -negative energy states – Approximate Hamiltonian for electrostatic problems-Spin of the Dirac particle- Bilinear covariants.

Books for study: Text Books 2 and 3

Module IV

Elements of Quantum Field Theory (18 Hours)

Euler-Lagrange equation for fields- Hamiltonian formulation -functional derivatives - conservation laws for classical field theory - Noether's theorem statement- Nonrelativistic quantum field theory -quantization rules for Bose particles, Fermi particles -relativistic quantum field theory – quantization of Klein Gordon field - quantization of Dirac field.

Book for study: Text Book 2

Text Books for study

1. *Modern Quantum Mechanics*, J.J.Sakurai, Pearson Education
2. *Quantum mechanics*, V.K.Thankappan, New Age Int. Publishers
3. *A Text Book of Quantum Mechanics*, P.M.Mathews & K.Venkatesan, Tata Mc Graw Hill Ltd.
4. *A Modern Approach to Quantum Mechanics*, John S. Townsend, Viva Books Pvt Ltd.

Reference

1. *Basic Quantum Mechanics*, Ajoy Ghatak and S Lokanadhan, Macmillan India Ltd.
2. *Quantum Mechanics: Concepts and Applications*, N.Zettile, John Wiley& Sons.
3. *Quantum Mechanics*, G Aruldhas, PHI Learning NewDelhi.
4. *Quantum Field Theory*, Lewis H. Ryder, Academic Publishers, Calcutta.
5. *Relativistic Quantum Mechanics,* James D. Bjorken and Sidney D. Drell,Mc Graw- Hill Book Company Inc.

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MODULE	PART A	PART B	PART C	TOTAL
I	3	2	1	6
II	3	2	1	6
III	2	2	1	5
IV	2	2	1	5
TOTAL	10	8	4	22

Model Question paper

Quantum Mechanics II

Time: 3 hrs   Max.weight: 30

Part A

Short answer Questions (answer any eight questions, each of weight 1)

1. Describe the time evolution operator in interaction picture.
2. What is Fermi golden rule? Explain.
3. Bring out Dyson series and its features.
4. Explain first Born approximation. Under which condition it is valid?
5. Explain Ramsauer Townsend effect.
6. Show that Klein Gordon equation satisfies probability conservation.
7. Write down the properties of Dirac matrices.
8. What are bilinear covariants? Explain their significance.
9. Write down the quantization rule for bosons.
10. Briefly discuss Noether's theorem and its significance.

Part B

Short Essay Questions/Problems (answer any six questions, each of weight 2)

11. Applying time dependent perturbation theory , find the transition probability for a constant perturbation.
12. Explain sudden and adiabatic approximation methods.
13. Derive the differential scattering cross section for Coulomb potential.
14. What is resonant scattering? Derive Breit-Wigner formula.
15. Show that orbital angular momentum for a Dirac particle is not a constant.
16. Prove the Lorentz covariance of Dirac equation.
17. Obtain Klein Gordon equation from Euler Lagrange field equation.
18. Discuss the field quantization of scalar field.

Part C

Long Essay Questions (answer any two questions, each of weight 5)

19. Apply time dependent harmonic perturbation for an atomic system in one state and get an expression for the probability of finding it in another discrete state. Also find the probability of transition to a continuum of final states.
20. Define differential scattering cross section. How it is related to scattering amplitude? Derive an expression for scattering cross section using partial wave analysis.
21. Obtain the plane wave solution of the Dirac free particle. What are large and small components?
22. Discuss the quantization of Klein-Gordon field.

PG3PHYC10- Computational Physics

COURSE OUTCOMES(CO)

CO1. Understand the curve fitting procedures and interpolation techniques. Applying this techniques in solving practical problems in physics. **PSO** - PSO4, **CL** - U,AP,C, **KC** - C,P

CO2. Methodology for numerically integrating and differentiating differential equations is understood, analyzing and applying the same to solve differential equations. **PSO** - PSO4, **CL** - U,AP,An,C, **KC** - C,P

CO3. Formulating the first order differential equations with their initialization conditions in physics, identifying and comparing the different numerical techniques for the accurate determination of the solution. **PSO** - PSO4, **CL** - AP,An,C, **KC** - C,P

CO4. Identify and recognize the different methods for solving linear system of equations, analyzing and formulating the linear equations in different physical problems , applying the knowledge to find the solution. **PSO** - PSO4, **CL**- U,AP,An,C, **KC**-C,P

Module I

Curve fitting and Interpolation (15 Hours)

Least squares curve fitting procedures- fitting a straight line, correlation coefficient, multiple linear least squares, linearization of non-linear laws, curve fitting by polynomials- parabola and cubic, Interpolation, errors in polynomial interpolation, finite difference operators, Newton's forward and backward formulae, Divided differences, Newton's general formula of interpolation, Lagrange's interpolation formula, inverse Lagrange's formula, interpolation by Iteration.

Module II

Numerical differentiation and integration (21 Hours)

Numerical differentiation- differentiation formulae using forward and backward differences, maximum and minimum of a tabulated function, Numerical integration- trapezoidal rule, Simpson's 1/3 and 3/8 rules and their errors, Boole's and Weddle's rules, Romberg's integration, Gaussian integration, Numerical calculation of Fourier integrals, Numerical double integration.

Module III

Numerical solution of differential equations (18 Hours)

Solution by Taylor's series, Picard's method of successive approximations, Euler's method of solving ODE, error estimates for the Euler method, Modified Euler's method, Runge-Kutta methods- second order and forth order, predictor-corrector methods- Adams Moulton method, Elementary ideas of finite difference method, solution of heat equation- Bender Schmidt method and Crank Nicholson method, concept of stability, Neumann stability check for Bender Schmidt formula.

Module IV

Numerical solution of a system of equations (18 Hours)

System of linear equations, solvability theory of linear systems, Direct methods-Gauss elimination, Gauss Jordan elimination method, Matrix inversion- Gauss method and Gauss Jordan methods to compute the inverse of matrices, Iterative methods - Jacobi method of simultaneous displacements, Gauss Seidel method of successive displacements, power method to find the eigen value of a matrix, Jacobi's method to solve Eigen value problem.

Books for study

1. Introductory methods of Numerical Analysis, 5th Edition, S. S. Sastry, PHI

Books for Reference

1. Elementary numerical analysis, 3rd Edition, Atkinson & Han, Wiley

2. Mathematical methods, G.Shanker Rao and K. Keshava Reddy, I. K. International Publishing house

3. An introduction to Computational Physics, 2nd Edition, Tao Pang, Cambridge University Press

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MODULE	PART A	PART B	PART C	TOTAL
I	3	2	1	6
II	3	2	1	6
III	2	2	1	5

IV	**2**	**2**	**1**	**5**
TOTAL	**10**	**8**	**4**	**22**

Model Question paper

Computational Physics

Time: 3 hrs Max.weight: 30

Part A

Short answer Questions (answer any eight questions, each of weight 1)

1. Show that the operators E and Δ satisfy $E \equiv (1 + \Delta)$.
2. Differentiate between interpolation and curve fitting.
3. Form the backward difference table for the following data

x	2	5	10
y	5	29	139

4. Using power method obtain how can one obtain the smallest Eigen value of a given matrix.
5. Find the dominant Eigen value and the corresponding Eigen vector of

$$A = \begin{bmatrix} 1 & 2 \\ 3 & 2 \end{bmatrix}$$

6. State Romberg rule for numerical integration
7. Discuss the two types of errors that occur in numerical differentiation
8. Why trapezoidal rule is so called?
9. Why do you say that Crank-Nicolson method is an implicit computational method?
10. Using Picards method solve the equation $y'=x+y^2$ upto second approximation subject to the condition y=1 when x=0. **Part B *Short Essay Questions/Problems (answer any six questions, each of weight 2)***
11. Find the interpolating polynomial for the following data using Lagrange's Formula

x	1	2	-4
y= $f(x)$	3	-5	4

12. By using the method of least squares, find a relation of the form $y = ax^b$, that fits the data

x	2	3	4	5

y	27.8	62.1	110	161

13. Find the largest Eigen value and the corresponding Eigen vector of the matrix

$$\begin{bmatrix} 3 & 1 & 4 \\ 0 & 2 & 6 \\ 0 & 0 & 5 \end{bmatrix}$$

14. Find the Inverse of the matrix

$$A = \begin{bmatrix} 2 & 0 & 1 \\ 3 & 2 & 5 \\ 1 & -1 & 0 \end{bmatrix}$$

15. Evaluate $\int_{0.2}^{0.5} e^x \sin 2x \; dx$ using Weddle's Rule.
16. Using modified Eulers method obtain the solution of the differential equation

$\frac{dy}{dx} = t + \sqrt{y} = f(t, y)$ with the initial condition y(0)=1 at t(0)=0 for the range 0≤t≤0.6 in steps of 0.2.

17. Find by Taylor series method the value of y at x=0.2 from $\frac{dy}{dx} = 2y + 3e^x$subject to the condition y=0 at x=0.
18. Obtain Bender-Schmidt recurrence formula.

Part C

Long Essay Questions (answer any two questions, each of weight 5)

19. Find the least squares parabolic fit of the form $\mathrm{y} = \mathrm{ax}^2 + \mathrm{bx} + \mathrm{c}$ to the following data.

x	-3	-1	1	3
y	15	5	1	5

20. Solve the following system of equations using Gauss-Seidel method of iterations and perform first five iterations.

$$2x_1 - x_2 = 7$$

$$-x_1 + 2x_2 - x_3 = 1$$

$$-x_2 + 2x_3 = 1$$

21. Derive Simpsons 1/3 rule for numerical integration. Evaluate $\int_0^2 \frac{1}{(x^2+x+1)} \mathrm{dx}$ with h=0.5

22. Usig Adams Moulton corrector predictor method, find the solution of the initial value problem $\frac{dy}{dx} = y - t^2$, y(0)=1.0, at t=0 taking h=0.2. Compare it with analytical solution.

V.5.Semester IV (Theory Courses)- Credits 4, Hrs 72

Common Courses

PG4PHYC11- Atomic and Molecular spectroscopy

COURSE OUTCOMES(CO):

CO1 Understand origin of different atomic spectra and effect of electric and magnetic fields on the spectra **PSO** - PSO 2 **CL** - U, **KC** - C,F

CO2 Understand origin of different molecular spectra and apply these spectroscopic tools to study the properties of elements and materials **PSO** - PSO 2 **CL** - U,AP, AN **KC** - C,F

CO3 Understand the theory and nature of Raman spectroscopy and its applications **PSO** - PSO 2 **CL** - U,AP, AN K**C** - C,F

CO4 Understand theories of NMR, ESR and Mossbauer Spectroscopy and applications **PSO** - PSO 2 **CL** - U,AP, AN **KC** - C,F

Module I

Atomic spectra (20 Hours)

Hydrogen atom and the emergence of quantum numbers– spinning electron and the vector model – normal order of fine structure doublets – electron spin orbit interaction – derivation of spin orbit interaction energy - spin orbit interaction for non-penetrating orbits - spectroscopic terms - fine structure in sodium atom, selection rules. Atom model for two valence electrons - L S and j j coupling schemes (vector diagrams) - examples, derivation of interaction energy. Hund's rule, Lande interval rule. Normal and anomalous Zeeman effects – vector model of one electron system in a weak magnetic field – magnetic moment of a bound electron – magnetic interaction energy – selection rules – examples. Paschen–Back effect – term values of strong field levels – examples. Normal Stark effect - examples. Width of spectral lines – natural width, Doppler effect, external effects. Hyperfine structure of spectral lines.

Books for study: Chapter 8, 10, 12 of Book [1]; Chapter 1 of Book [2]

Module II

Microwave, Infrared and Electronic spectroscopy

Microwave spectroscopy (5 Hours): Rotational spectra of diatomic molecules - intensity of spectrallines - effect of isotopic substitution. Non–rigid rotor - rotational spectra of polyatomic molecules - linear and symmetric top - Interpretation of rotational spectra.

IR spectroscopy (8 Hours): Vibrating diatomic molecule as anharmonic oscillator, diatomic vibrating rotor – break down of Born-Oppenheimer approximation - vibrations of polyatomic molecules - overtone and combination frequencies - influence of rotation on the spectra of polyatomic molecules - linear and symmetric top - analysis by IR technique - Fourier transform IR spectroscopy.

Electronic spectroscopy (5 Hours): Electronic spectra of diatomic molecules - progressions and sequences - intensity of spectral lines. Franck – Condon principle - dissociation energy and dissociation products - Rotational fine structure of electronic-vibrational transition - Fortrat parabola - Pre- dissociation

Books for study: Chapter 2, 3, 5 of Book [3]; Chapter 6, 7, 9 of Book [4]

Module III

Raman spectroscopy (16 Hours)

Pure rotational Raman spectra - linear and symmetric top molecules - vibrational Raman spectra – Raman activity of vibrations - mutual exclusion principle - rotational fine structure - structure determination from Raman and IR spectroscopy.

Non- linear Raman effects - hyper Raman effect - classical treatment - stimulated Raman effect - CARS, PARS - inverse Raman effect

Books for study: Chapter 4, Book [3]; Chapter 8, Book [4]

Module IV

Spin resonance spectroscopy (18 Hours)

NMR: Quantum mechanical and classical descriptions - Bloch equations - relaxation processes - chemical shift - spin–spin coupling - CW spectrometer - applications of NMR.

ESR: Theory of ESR - thermal equilibrium and relaxation - g- factor - hyperfine structure -applications

Mossbauer spectroscopy: Mossbauer effect - recoilless emission and absorption - hyperfine interactions – chemical isomer shift - magnetic hyperfine and electronic quadrupole interactions - applications

Books for study: Chapter 7 & 9, Book [3]; Chapter 10, 11 & 13, Book [4]

Books for study

1. Introduction to atomic spectra, H E White, McGraw Hill Kogakusha, Ltd.
2. Spectroscopy, B. P. Straughan & S. Walker, Vol. 1, John Wiley & Sons.
3. Fundamentals of molecular spectroscopy, 4th Edition, C.N. Banwell, Tata McGraw Hill
4. Molecular structure and spectroscopy, 2nd Edition, G. Aruldhas, PHI Learning Pvt. Ltd.

BLUE PRINT

MODULE	PART A	PART B	PART C	TOTAL
I	3	2	1	6
II	2	2	1	5
III	2	2	1	5
IV	3	2	1	6
TOTAL	10	8	4	22

Model Question paper

Atomic and Molecular Spectroscopy

Time: 3 hrs Max.weight: 30

Part A (*Short answer Questions, answer any eight questions, each of weight 1)*

1. Explain different quantum numbers according to vector atom model
2. How does Doppler Effect causes broadening of a spectral line? How it can be minimized
3. Explain the origin of sodium d1 and d2 line
4. Explain the chemical shift in NMR
5. What is polarisability ellipsoid
6. What is born oppenheimer approximation
7. Explain mutual exclusion principle
8. Explain the stimulated Raman scattering with the help of energy level diagram
9. Explain the pure rotational Raman spectra of a linear molecule

10. What is population inversion?

Part B

Short Essay Questions/Problems (answer any six questions, each of weight 2)

11. Explain LS coupling scheme for two electron systems in pd configuration and write down all term values
12. Briefly explain the FRIR spectrometer with schematic diagram. List its advantages over dissipative instruments
13. Discuss Raman activity of vibrations in H2O and CO2 molecules
14. Discuss the rotational spectra of symmetric top molecule
15. Give the theory of a diatomic vibrating rotator and explain the resulting energy bands
16. Explain recilness emission and absorption of gamma rays. How it can be utilized for Mossbauer spectroscopy
17. Obtain the expression for rotational term value of a non-rigid rotator
18. Explain the pumping mechanism used in lasers

Part C

Long Essay Questions (answer any two questions, each of weight 5)

19. Explain Raman effect. Give quantum mechanical explanation of Raman effect. Give the experimental setup to observe Raman effect
20. Discuss the stark splitting in one electron system b) briefly explain paschen back effect and derive expression for interaction energy
21. Obtain the Einstein's coefficients
22. A) Discuss the effect of isotopic substitution into rotational spectra of a diatomic molecule b) Explain the formation of P and R branches in rotational vibrational spectra.

PG4PHYC12- Nuclear and Particle Physics

COURSE OUTCOMES(CO):

CO1. Understand the nuclear properties like mass, radius binding energy, electric and magnetic moments etc and different nuclear models and nuclear structure. Applying these concepts in understanding the nuclear scattering ,nuclear interactions.**PSO** - PSO2, **CL** - U,AP,An, **KC** - C,P.

CO2. Differentiate the different nuclear decay processes and the theories related to them and identify and apply the same for solving nuclear decay and disintegration processes. **PSO** - PSO2, **CL** - U,AP,An, **KC** - C,P.

CO3. Understanding the different nuclear reactions and the theory behind it. Identifying the application of the same in different nuclear reactors**. PSO** - PSO2, **CL**-U,AP,An, **KC**-C,P.

CO4. Factual information related to the elementary particles, their classification, experimental evidences, quark model of particles, quark dynamics and theories on unification of forces **.PSO** - PSO2, **CL** - U, An,C, **KC** - F,P.

Module I (22 Hours)

Nuclear properties (14 hours)

Nuclear radius-Distribution of nuclear charge and distribution of nuclear matter, Nuclear mass- Mass spectrograph, Mass doublet method, Abundance of nuclides-Isotope separation, nuclear binding energynuclear angular momentum and parity, nuclear electromagnetic moments, The deuteron, Properties of deuteron-binding energy, spin and parity, magnetic dipole moment and electric quadrupole moment, nucleon-nucleon scattering, proton - proton and neutron - neutron interactions, properties of nuclear force, exchange force model

Nuclear models (8 hours)

Liquid drop model, shell model of nucleus-shell model potential, spin-orbit potential, magnetic dipole moment and electric quadrupole moment according to shell model, valence nucleons, collective structure-Nuclear vibrations and Rotations.

Books for study: Book [1], Chapters 3, 4 & 5

Module II

Nuclear decay (18 Hours)

Alpha decay- reason, basic alpha decay processes, alpha decay systematics, theory of alpha emission, angular momentum and parity in alpha decay, Beta decay, neutrino, energy release in beta decay, Fermi's theory of beta decay, classical experimental tests of Fermi's theory- shape of beta spectrum, total decay rate, Angular momentum and parity selection rules- allowed decays and forbidden decays, neutrino physics, non-conservation of parity in beta decay, gamma decay-energetics of gamma decay, angular momentum and parity selection rules, internal conversion.

Books for study: Book [1], Chapters 8, 9 & 10

Module III

Nuclear reactions (18 Hours)

Types of reactions and conservation laws, energetics of nuclear reactions, reaction cross sections, coulomb scattering, nuclear scattering, scattering cross sections, the optical model, compound nucleus reactions, direct reactions, resonance reactions, nuclear fission, reason for fission, characteristics of fission, basic fusion processes, characteristics of fusion.

Books for study: Book [1], Chapters 11, 13 & 14.

Module IV

Particle Physics (14 Hours)

Elementary particles-leptons quarks, particle quantum numbers, symmetries and conservation laws, CPT invariance, Quark model-u, d, s quarks, Gell-mann's fold path, deep inelastic scattering, coloured quarks and gluons-colour, hadrons, Gellmann Nishijima formula, reactions and decays in quark model, charm, beauty and truth, quark dynamics, unification of forces-symmetry breaking, Electroweak theory and its predictions, Higgs boson, Grand Unified Theory, predictions of GUT, search for proton decay.

Books for study: Book [1], Chapters 18

Book for study

1. *Introductory nuclear physics*, Kenneth S. Krane, Wiley

Books for Reference

1. *Introduction to nuclear physics*, Harald A. Enge, Addison Wesley
2. *The atomic nucleus*, R. D. Evans, McGraw-Hill
3. *Nuclear physics*, I. Kaplan, Addison Wesley
4. *Introduction to elementary particles*, 2nd Edition, David Griffths, Wiley
5. *Elementary particles and symmetries*, Lewis H. Ryder, Gordon & Breach Science

BLUE PRINT

MODULE	PART A	PART B	PART C	TOTAL
I	3	2	1	6

II	**3**	**2**	**1**	**6**
III	**2**	**2**	**1**	**5**
IV	**2**	**2**	**1**	**5**
TOTAL	**10**	**8**	**4**	**22**

Model Question paper

Nuclear and Particle Physics

Time: 3 hrs Max.weight: 30

Part A

Short answer Questions (answer any eight questions, each of weight 1)

1. What is meant by binding energy of a nucleus? Write down Bethe-Wiezacker formula of binding energy.
2. Explain the measurement of mass of a nuclus using mass doublet method.
3. Write a note on electric quandrupole moment of a nucleus.
4. Give the Gell-Mann Nishijima formula and explain the terms
5. Briefly explain quark flavours and colours.
6. Explain electron capture and positive beta decay. Which process is energetically more favourable?
7. Explain the shape of beta decay spectrum.
8. What is meant by Gamma Decay? Give expression for the energy of emitted gamma photon.
9. Define heavy ion reaction.
10. Define elastic scattering and inelastic scattering in nuclear reactions.

Part B

Short Essay Questions/Problems (answer any six questions, each of weight 2)

11. Write a note on collective model of a nucleus.
12. Derive the radius of deuteron by considering it a s particle in a rectangular potential well.
13. Write a note on Gell-Mann's eight fold path in classifyting elementary particles.
14. Write a short note on electroweak theory and GUT.
15. Give the selection rule angular momentum and parity in beta decay transition.
16. What is parity? Describe the experiment illustrating non-conservation of parity in beta decay
17. Describe proton-proton cycle and CNO cycle.

18. Explain direct reactions. Give important types of direct reactions.

Part C

Long Essay Questions (answer any two questions, each of weight 5)

19. Discuss the shell model of a nucleus and show that magic numbers, spin and magnetic moments of a nucleus can be explained with the help of shell model.
20. Write a note on the quantum numbers and different conservation laws associated with elementary particles.
21. Describe Gamows theory of beta decay. Hence deduce Geiger-Nuttall Law.
22. Describe the theory of nuclear fission. What are its main characteristics? Obtain products and amount energy released in the fission of uranium-235.

V.6.Semester III Theory Group A Elective courses

PG3PHYEA01- Astrophysics

COURSE OUTCOMES(CO):

CO1. Understand the physics and mechanism of the gravitational collapse of massive clouds of particles and formation of stars. **PSO** - PSO2, **CL** - U, **KC** - C, F

CO2. Understand the nature of electrons and photons in the interior of stars and the kinds of possible pressures in stars. **PSO** - PSO2, **CL** - U, **KC** - C, F

CO3. Understand the physics of fusion of hydrogen, helium and the heavy elements in the core of stars. **PSO** - PSO2, **CL** - U, **KC** - C, F

CO4. Understand the processes of heat-transfer across the stellar layers. **PSO** - PSO2, **CL** - U, **KC** - C, F

CO5. Understand the evolutionary tracks of stars leading to the three stellar dead materials. **PSO** - PSO2, **CL** - U, **KC** - C, F

CO6. Understand stellar atmosphere and learn how star could be modelled. **PSO** - PSO2, **CL** - U, Ap, **KC** - F, P

Module I

Stellar evolution: Early stages (18 Hours)

Birth of stars, Primordial nucleosynthesis, Gravitational contraction, Hydrostatic Equilibrium, Virial theorem, Equilibrium of a cloud of non relativistic particles, equilibrium of a cloud of ultra-relativistic particles, Gravitational collapse, Free fall time, Jeans mass, protostar, contraction of protostar, conditions for stardom, The sun, central pressure of Sun. Stellar nucleosynthesis, The Hertzsprung-Russel diagram, Magnitudes, Distance modulus, Stellar parallax.

Module II

Matter and radiation in star (18 Hours)

Stellar material, Electrons in star, Classical electron gas and equation of state, Quantum concentration, degenerate electron gas and equation of state, density-temperature diagram, electrons in sun, electrons in massive stars, photons in star, photon gas, radiation pressure in star, ionization in star, Saha's equation, stellar interiors, stellar atmosphere.

Module III

Fusion and heat transfer in star (18 Hours)

Physics of nuclear fusion, barrier penetration, fusion cross section, Hydrogen burning-proton-proton chain and CNO chain, solar neutrinos, red giant, Helium burning and temperature condition, Red Super giant, Advanced burning and temperature conditions, Heat transfer by conduction of ions and electrons, heat transfer by radiation and its comparison with conduction, opacity and expression for temperature gradient, convection and convective gradient.

Module IV

Stellar structure and stellar evolution (18 Hours)

Simple stellar models- polytropic model and Clayton model, pressure, density and temperature in stars, Low mass star evolution- White dwarf –maximum mass(Chandrasekhar limit), size and density, Type I Supernova, High mass star evolution- Type II Supernova, Neutron star, maximum mass of neutron star(Tolman-volkoff limit), size and density, pulsars, properties of pulsars, Black hole- formation of Black hole, singularity and event horizon, brief idea about Hawking radiation.

Book for study

1. *The physics of stars*, 2nd Edition, A C Philips, John Wiley & Sons

Books for Reference

1. *An introduction to modern astrophysics*, Bradley W Carrol, Dale A Ostlie, 2ndEdition, Pearson
2. *Introductory Astronomy & Astrophysics*, 4th Edition, Zeilik and Gregory, Cengage Learning
3. *Stars, their structure and evolution*, 2nd Edition, R. J. Taylor, Cambridge University Press
4. *A Brief History of Time: From Big Bang to Black Holes*, Stephen Hawking, Bantam Dell Publishing Group (1988)

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MODULE	PART A	PART B	PART C	TOTAL
I	3	2	1	6
II	3	2	1	6
III	2	2	1	5
IV	2	2	1	5
TOTAL	10	8	4	22

Model Question paper

Astrophysics

Time: 3 hrs Max.weight: 30

Part A

Short answer Questions (answer any eight questions, each of weight 1)

1. Why are the elements lighter than iron such as hydrogen, helium, carbon and oxygen are abundant in the Universe than elements heavier than iron?
2. What is Kramer's law in Astrophysics?
3. Distinguish between type I and type II supernovae
4. What is Schwarzchild radius? Write down the mathematical formula for it
5. What you meant by Jeans mass?
6. What is stellar parallax?Find the distance to a star whose parallax ix 0.85 seconds of arc?
7. Write the mathematical expression for pressure gradient inside an ideal star?
8. What you meant by electron degeneracy pressure?
9. Find average pressure exerted by stellar core which is considered as an ideal gas of non relativistic particles

10. Define quantum concentration. Find an expression for the same.

Part B

Short Essay Questions/Problems (answer any six questions, each of weight 2)

11. Define Gamow energy. How is it related to thermonuclear reactions in stars?
12. Discuss briefly the polytropic model of star
13. Calculate the Q value of the following: d + d $\rightarrow$He^3 + n ; d + d$\rightarrow$H^3 + p; assuming that this occurs with deuterons at rest find the kinetic energies of the outgoing particles in each case
14. Write a note on Hawking process
15. What is free fall time? Derive a formula for the same if a cloud of gas has uniform density.
16. Briefly explain H-R diagram of stars.
17. What is radiation pressure inside a star? Show that it is proportional to T^4.
18. Derive equation of state of a degenerate electron gas of non relativistic particles

Part C

Long Essay Questions(answer any two questions, each of weight 5)

19. Write an essay on CNO cycle and the various pp reactions
20. Describe a white dwarf. What are their physical characteristics? Derive Chandrasekhar mass
21. What is hydrostatic equilibrium of a star? Explain virial theorem and derive conditions of equilibrium for a gas of non relativistic and ultra relativistic particles.
22. Derive Saha's ionization equation. Explain its significance.

PG3PHYEA02- NON LINEAR DYNAMICS AND CHAOS

COURSE OUTCOMES(CO):

CO1 Understand the basic ideas of non linear system , chaos and fractals **PSO** - PSO 1, **CL** - U, AP, **KC** - C, F

CO2 Catogorising 1D, 2D and 3D phase space dynamics and asses them to solve the problems **PSO** - PSO 1,PSO2, **CL**- U,AP, AN, **KC** - C, F

CO3 Correlate the different routes to chaos for a dynamical system **PSO** - PSO 2 **CL** - U,AP, AN, **KC** - C, F

CO4 Examine the different mapping procedures, measure the degree of chaos and identifying the universality of chaos **PSO** - PSO 2 **CL** - U,AP, AN **KC** - C, F

Module I

Dynamics of One and Two dimensional systems (18 hrs)

Linear and Nonlinear Systems, Determinism, Unpredictability and Divergence of Trajectories, State Space, Systems Described by First-Order Differential Equations, The No-Intersection Theorem, Dissipative Systems and Attractors, One-Dimensional State Space, Taylor Series Linearization near Fixed Points, Trajectories in a One-Dimensional State Space, Two-Dimensional State Space: The General Case, Dynamics and Complex Characteristic Values, Dissipation and the Divergence Theorem, The Jacobian Matrix for Characteristic Values, Limit Cycles, Poincare Sections and the Stability of Limit Cycles, Bifurcation Theory.

Books for study: Book 1 [Chapter1,3]

Module II

Dynamics of three dimensional systems (18 hrs)

Overview, Routes to Chaos, Three-Dimensional Dynamical Systems, Fixed Points in Three Dimensions, Limit Cycles and Poincare Sections, Quasi-Periodic Behavior, The Routes to Chaos -1)Period-Doubling, 2)Quasi-Periodicity, 3)Intermittency and Crises and 4)Chaotic Transients and Homoclinic Orbits, Homoclinic Tangles and Horseshoes, Lyapunov Exponents and Chaos.

Model of Convecting Fluids-The Lorenz Model, The Duffing Double well oscillator, The van der Pol Oscillator.

Books for study: Book 1 [Chapter 1, 4, Appendices G and I]

Module III

Hamiltonian Systems (18 hrs)

Introduction, Hamilton's Equations and the Hamiltonian, Phase Space, Liouville’s theorem and phase space distribution, Constants of the Motion and Integrable Hamiltonians, The simple Harmonic oscillator, The Pendulum, Systems wih N degrees of freedom, Nonintegrable Systems, the KAM Theorem and Period Doubling, Poicare-Birkoff Theorem, Arnold Cat Map, Chirikov Standard Map, Dissipative Standard Map.

Books for study: Book 1 [Chapter 8]

Module IV

Quantifying Chaos (9 hrs)

Introduction, Time-Series of Dynamical Variables, Lyapunov Exponents, Universal Scaling of the Lyapunov Exponent, Invariant Measure, Kolmogorov-Sinai Entropy, Correlation Dimension , Fractal Dimension(s).

The Universality of Chaos (9 hrs)

Introduction, The Feigenbaum Numbers, Convergence Ratio for Real Systems, Feigenbaum Size Scaling, Self-Similarity, Other Universal Features, Fractals-Cantor set, Koch curve.

Books for study: Book 1 [Chapter 2,9] Book 2 [Chapter6]

Books for study:

1. *Nonlinear Dynamics and Chaos: R. C. Hilborn.*
2. *Deterministic Chaos: N. Kumar, Universities Press.*

Books for Reference:

1. *Nonlinear Dynamics and Chaos with applications to Physics, Biology, Chemistry and Engineering*, Steven H. Strogatz..
2. *Deterministic Chaos*, N. Kumar, Universities Press.
3. *Nonlinear dynamics: integrability, chaos, and patterns*, M. Lakshmanan & S. Rajasekar, Springer Verlag,
4. *Chaotic Dynamics: An Introduction*, G.L. Baker, and J.P. Gollub, CUP, 1993.
5. *Deterministic Chaos*, H.G. Schuster, Wiley, N.Y., 1995.
6. *Chaos in Dynamical System*, E. Ott, Cambridge University Press.
7. *Encounters with Chaos*, D. Gullick, MGH, 1992.
8. *Introduction to Chaos and coherence*, J. Froyland, IOP Publishing Ltd.
9. *Nonlinear Dynamics and Chaos*, J.M.T. Thomson& I. Stewart, John Wiley & Sons.

BLUE PRINT

MODULE	PART A	PART B	PART C	TOTAL
I	3	2	1	6
II	3	2	1	6
III	2	2	1	5

IV	**2**	**2**	**1**	**5**
TOTAL	**10**	**8**	**4**	**22**

Model Question paper

Non-Linear Dynamics and Chaos

Time: 3 hrs Max.weight: 30

Part A

Short answer Questions (answer any eight questions, each of weight 1)

1. Distinguish between Autonomous and non-autonomous systems.
2. What are fixed points? Give its significances.
3. State and explain the Poincare-Bendixen theorem.
4. Write the Lorenz equations.
5. Explain the four basic types of fixed points for a 3D-system.
6. What is Hopf bifurcation?
7. what are invariant tori.
8. Give the physical significances of Feigenbaum numbers.
9. Explain the cantor set.
10. What is a logistic map? What happens to the map when the control parameters has a value greater than 4?

Part B

Short Essay Questions/Problems (answer any six questions, each of weight 2)

11. Find all fixed points for the system, $\dot{x} = x^2 - 1$; and discuss their stability.
12. Explain the stability of limit cycle using Poincare Section method.
13. Discuss the system, Vander pol oscillator.
14. Explain the method of quantifying chaos using Lyapunov exponent.
15. For the logistic equation, $x_{n+1} = ax_n(1 - x_n)$. Find out the peroid 2 equilibrium points.
16. Give a short note on strange non chaotic attractors.
17. Explain the Kolmogorov- Sinai entropy.
18. Discuss the fractal dimensions and give the fractal dimension of Koch – curve.

Part C

Long Essay Questions (answer any two questions, each of weight 5)

19. Explain the general case of two-dimensional systems.
20. Discuss the various routes to chaos.
21. Explain the universality of chaos.
22. Distinguish between integrable and non-integrable systems. Explain the importance of KAM theorem.

V.7.Semester IV Theory Group A Elective courses

PG4PHYEA03- Gravitation and Cosmology

COURSE OUTCOMES(CO):

CO1. Understand the concept of tensors and tensor algebra; apply the knowledge in the analysis of the properties of its mathematical space. **PSO** - PSO1, **CL** - U, Ap, An, **KC** - C, P

CO2. Understand General Relativity theory and its consequences. **PSO** - PSO2, **CL** - U, **KC** - C

CO3. Learn to apply General Relativity to the problem of the gravitational field of a sphere of mass. **PSO** - PSO2, **CL** - U, Ap, **KC** - P

CO4. Learn how to apply Gravitational field equation to a space of FRW metric. **PSO** - PSO2, **CL** - U, Ap, **KC** - P

CO5. Understand the current cosmological facts about the Universe. **PSO** - PSO2, **CL** - U, **KC** - F

Module I

Tensor analysis (18 Hours)

A review of tensors and properties, product of tensors, direct product, inner product and contraction, quotient rule, metric tensor, parallel transport of vectors, Christoffel symbols, covariant derivative, Riemannian geometry, Riemann curvature tensor, Ricci tensor, Ricci scalar, Einstein tensor, derivation of the equation of geodesic

Module II

Formulation of GTR (18 Hours)

Drawbacks of Newtonian theory of gravity, Mach's principle, principle of equivalence, consequences of principle of equivalence (bending of light and redshift), Gravity as curvature of space-time, Curvature tensor, Properties of curvature tensor, Energy-momentum tensor, Bianchi identity, Einstein's tensor, Einstein's field equation, Reduction to Newtonian gravity. Einstein's field equation from action principle (Qualitative ideas)

Module III

Schwarzchild solution of Einstein’s equation (18 Hours)

Centrally symmetric gravitational field, Schwarzchild metric, Schwarzchild solution-derivation, Schwarzchild radius- black hole, Gravitational redshift, precession of the perihelion- planet mercury, Bending of light, gravitational time dilation, gravitational redshift, gravitational waves and detectors (qualitative ideas)

Module IV

Cosmology (18 Hours)

Cosmological principle, Hubble’s law, Hubble parameter, FRW metric, Friedmann models- closed, flat and open models, Energy –momentum tensors of the universe, Conservation law, matter dominated and radiation dominated universes, cosmological redshift, particle horizon and event horizon, Early universe, CMBR and its temperature, primordial nucleosynthesis, flaws of FRW model-flatness problem, horizon problem, age problem, Inflation(qualitative), dark matter, dark energy and acceleration of the universe (qualitative).

Books for study

1. *An introduction to Relativity*, J. V. Narlikar, Cambridge University press
2. *Introduction to cosmology*, 3rd Edition, J. V. Narlikar, Cambridge University press

Books for Reference

1. *Theory of Relativity*, 2nd Edition, R. K. Pathria, Dover Publications
2. *Classical theory of fields*, 4th Edition, L D Landau and E M Lifshitz, Elsevier
3. *Principles of cosmology and gravitation*, Michael V Berry, IOP Publishing Company
4. *Tensor Analysis: Theory and Applications*, 2nd Edition, I S Sokolnikoff, Wiley

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MODULE	PART A	PART B	PART C	TOTAL
I	3	2	1	6
II	3	2	1	6
III	2	2	1	5
IV	2	2	1	5
TOTAL	10	8	4	22

Model Question paper

Gravitation and Cosmology

Time: 3 hrs Max.weight: 30

Part A

Short answer Questions (answer any eight questions, each of weight 1)

1. What do you mean by inner product of two tensors?
2. What is parallel transport of a vector?
3. Why do we say that Christoffel symbols are not tensors?
4. Distinguish between dark matter and dark energy
5. What is the observational evidence for the idea of acceleration of the Universe?
6. State Mach's principle?
7. Define Bianchi identity.
8. What is strong principle of equivalence?
9. Is gravitational time dilation is real? Justify your answer.
10. Define energy momentum tensor of an ideal cosmic fluid.

Part B

Short Essay Questions/Problems (answer any six questions, each of weight 2)

11. Derive the equation of geodesic
12. What do you mean by metric tensor? Obtain the metric tensors for the flat Cartesian, Spherical polar and Cylindrical polar spaces
13. Write a note on cosmological principle
14. What is the nature and significance of CMBR?
15. What is Einstein tensor? Show that it is divergenceless.
16. Explain gravitational redshift. Derive a forfula for it.
17. What is Schwarzschild radius? What is Schwarzschild radius of earth(Mass of earth is $6x10^{24}$kg)?
18. How Einstein's GTR account for precession of perihelion of planet mercury and bending of light?

Part C

Long Essay Questions (answer any two questions, each of weight 5)

19. Derive the expression for Riemann curvature tensor
20. Discuss Friedmann models of the Universe

21. Show that Einstein’s equations leads to Newtonian theory of gravity in the appropriate limit.
22. Derive the Schwarzschild metric.

PG4PHYEA04- Quantum Field Theory

COURSE OUTCOMES(CO):

CO1. Understand and execute the concept of quantization of classical and quantum fields to get field propagators. **PSO** - PSO 5, **CL** - U, Ap, **KC** – F, C

CO2. Analyse the Feynmann rules to compute S- matrix elements in perturbation theory **PSO** - PSO 5, **CL** - An, Ap, **KC** – C, P

CO3. Examine the functional quantization techniques and symmetry properties for scalar, vector and spinor fields **PSO** - PSO 5, **CL** - An, Ap, **KC** – C

CO4. Apply the gauge theories with spontaneous symmetry breaking, to verify the theory of weak interactions **PSO** - PSO 5, **CL** - Ap, An, **KC** – C, P

Module I (18 Hours)

The Klein Gordon Field:

Elements of classical field theory - Lagrangian field theory, Hamiltonian field theory and Noether’s theorem, The Klein-Gordon field in space time. Causality: The Klein Gordon propagator.

The Dirac field:

The Dirac equation: Weyl Spinors, Dirac Matrices and Dirac field bilinears, Quantization of Dirac field: The Dirac propagator, Discrete symmetries of Dirac theory - Parity, Time reversal and charge conjugation

Book for study: Book 1, Chapters 2 & 3

Module II (18 Hours)

Interacting fields and Feynman diagrams: Perturbation Theory: Perturbation expansion of correlation functions, Wick’s theorem, Feynman diagrams: two point and four point functions, symmetry factor, Feynman rules in $\varphi 4$ theory, momentum space Feynman rules, Cross sections and the S- matrix (qualitative ideas only).

Book for study: Book 1, Chapter 4

Module III (18 Hours)

Path Integral formalism: Path Integrals in quantum mechanics, Functional quantization of scalar fields - Correlation functions – Feynman rules, Functional derivatives and generating functional, Quantization of electromagnetic field – Photon propagator, Functional quantization of spinor fields – Anticommuting numbers, The Dirac propagator, Generating functional for Dirac field.

Book for study: Book 1, Chapter 9

Module IV (18 Hours)

Gauge theories and spontaneous Symmetry breaking:

Spontaneous symmetry breaking, Linear sigma model, Goldstone theorem, Interactions of Non-Abelian Gauge bosons: Feynman rules for fermions and gauge bosons, The Faddeev-Popov Lagrangian, The Higg's mechanism – an abelian example.

Book for study: Book 1, Chapters 11, 16, 20

Books for study

1. *An Introduction to quantum field theory*, 1995, Michael E. Peskin & Daniel

V. Schroeder, Westview Press, Chapter 16, 20.

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MODULE	PART A	PART B	PART C	TOTAL
I	3	2	1	6
II	2	2	1	5
III	3	2	1	6
IV	2	2	1	5
TOTAL	10	8	4	22

Model Question paper

Quantum Field Theory

Time: 3 hrs Max.weight: 30

Part A

Short answer Questions (answer any eight questions, each of weight 1)

1. Give the Feynman propagator for a Klein Gordon field.
2. State and explain Noether's theorem.
3. What is causality?
4. Explain the Feynman rules in φ^4theory.
5. What is meant by S-matrix?
6. Give the properties of anti-commuting numbers.
7. Explain the four-point correlation function.
8. What are gauge bosons?
9. State and explain the Goldstone theorem.
10. Explain the significances of Faddeev - Popov Lagrangian?

Part B

Short Essay Questions/Problems (answer any six questions, each of weight 2)

11. Obtain the Weyl equations.
12. Prove that 'No measurement in Klein Gordon theory can affect another measurement outside the light cone'.
13. Explain the Wick's theorem.
14. Outline the momentum space Feynman rules.
15. Explain the generating functional for Dirac field.
16. Explain the quantisation of Electro-magnetic field.
17. Write a note on spontaneous symmetry breaking.
18. Explain the Higgs mechanism.

Part C

Long Essay Questions (answer any two questions, each of weight 5)

19. Explain the quantization of Dirac field.
20. Discuss the perturbation expansion of correlation functions.
21. Explain the method of path integrals in quantum mechanics.
22. Explain the Feynman rules for fermions and gauge bosons.

V.8.Semester III Theory Group B Elective courses

PG3PHYEB01- Semiconductor device Physics and Microelectronics

COURSE OUTCOMES(CO):

CO1. To understand and distinguish the theory behind the constructional features of semiconductor devices like Schottky diode, JFET, MESFET, MOSFET and IGBT. **PSO** - PSO3, **CL** - U,Ap, **KC** - C,P

CO2. To analyze qualitatively and quantitatively the operational principles of semiconductor devices. **PSO** - PSO3, **CL** - U,An, **KC** - F,P

CO3. To Understand the internal architecture and programming of 8051 microcontroller and thus to analyze and solve various problems in Physics. **PSO** - PSO3, **CL** - U,An,Ap, **KC** - C,P

Module I

Metal-Semiconductor contacts and Schottky Diodes (16 Hours)

Ideal MS contacts - Schottky Diodes: Electrostatics, Non-ideal effects on barrier heights (image force induced lowering of the potential barrier, interface states), Current transport across a metal semiconductor boundary, Comparison of the Schottky Barrier Diode and the pn junction diode, MS Ohmic contacts: Ideal non rectifying barriers, Tunnelling barrier - Heterojunctions: Heterojunction materials, Energy-band diagrams, Two-Dimensional Electron Gas

Books for study: Book [1] and Book [2]

Module II: Field Effect Devices (20 Hours)

JFET: Qualitative theory of operation, Quantitative I_D- V_D relationships, AC response – MESFET

MOSFET: Qualitative theory of operation, Quantitative I_D-V_D relationships, Preliminary considerations: Threshold Voltage, Effective mobility - Square law theory - AC Response: Small signal equivalent circuits, Cut off frequency

Nanoscale MOSFETs, downscaling rules and their effects - MOS based memory devices: 1C1T DRAM cell, Flash Memory cell

Books for study: Book [1] and Book [3]

Module III

The Insulated Gate Bipolar Transistor (16 Hours)

IGBT: Basic structure - I-V Characteristics - Physics of device operation: Blocking state operation, On-state operation - Latch up in IGBTs: causes of latch up, avoidance of latch up - Device limits and SOAs

Book for study: Book [4]

Module IV

The 8051 Microcontroller (20 Hours)

Microprocessor and Microcontroller - Internal architecture - Program and data memory organization

I/O ports and Special Function Registers - SFR map, functions - PSW - Accumulator -Register B - Stack pointer - Port registers – PCON

Addressing modes and data move operations - Arithmetic operations – Program branching - Subroutines and Stack - Logical operations - Boolean variable manipulation

Programming examples: Copy block, Shift block, Sum of a series, Fibonacci series, Largest and smallest integers in an array, Bubble sorting.

Book for study: Book [5]

Books for study

1. *Semiconductor Device Fundamentals with Computer Based Exercises and Homework Problems*, Robert F. Pierret
2. *Semiconductor Physics and Devices*, 4e, Donald A Neamen, Dhrubes Biswas
3. *Principles of Semiconductor Devices* (Second Edition), Sima Dimitrijev, Oxford University Press, Chapter 8, 13
4. *Power Electronics: Converters, Applications and Design*, Ned Mohan, Tore M. Undeland, William P. Robbins, Wiley
5. *8051 Microcontroller, Internals, Instructions, Programming and Interfacing*, Second Edition, Subrata Ghoshal, Pearson

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MODULE	PART A	PART B	PART C	TOTAL
I	3	2	1	6
II	3	2	1	6
III	2	2	1	5
IV	2	2	1	5

TOTAL	**10**	**8**	**4**	**22**

Model Question paper

Semiconductor Device Physics and Microelectronics

Time: 3 hrs Max.weight: 30

Part A

Short answer Questions (answer any eight questions, each of weight 1)

1. What is Schottky effect?
2. What are the essential qualities of good ohmic contacts to a semiconductor? How are they realised?
3. Compare a Schottky diode and a PN junction diode.
4. What is pinch-off voltage?
5. What do MESFET, D-MESFET and E-MESFET stand for?
6. Draw the low and high frequency equivalent circuits of a FET.
7. Explain why an IGBT is called so?
8. Mention the applications of IGBT.
9. Differentiate microprocessors and microcontrollers.
10. What is a program counter and data pointer?

Part B

Short Essay Questions/Problems (answer any six questions, each of weight 2)

11. Using energy level diagrams, discuss the changes at the metal – n type semiconductor interface when a contact is formed.
12. Explain Two dimensional Electron Gas
13. Arrive at expressions for the drain conductance and the transconductance of an FET by considering its ac equivalent circuit.
14. Write an account on MOS-based memory devices.
15. Explain the electrical equivalent circuit model of IGBT.
16. Draw and explain the following for the IGBT: (a) Static I-V characteristics (b) Transfer characteristics (c) Dynamic characteristics.
17. Explain how stacks are accessed in 8051.
18. Discuss the 8051 addressing modes with examples.

Part C

Long Essay Questions (answer any two questions, each of weight 5)

19. Discuss the thermionic emission charge transport theory across a Schottky barrier.
20. Explain the square law theory of MOSFET operation and arrive at an expression for the Drain current.
21. Explain the construction and working of an IGBT.
22. Discuss the architecture of 8051 Microcontroller.

PG3PHYEB02- Material Science

COURSE OUTCOMES(CO):

CO1. Understand and distinguish between various types of crystal imperfections and to get knowledge about phase diagrams and laws of diffusion. PSO - PSO2,**CL**- U, An,Ap, **KC** -C,F

CO2. To get knowledge about formation of thin films and properties of nanostructured materials. **PSO** - PSO2, **CL** - U, An, **KC** - C,F

CO3. To understand , differentiate and analyze various methods for the preparation and characterization of thin films and nanomaterials. **PSO** - PSO2,**CL** - U,An,Ap, **KC** - C,P

CO4. Understand the various applications of thin films and nanostructured materials. **PSO** - PSO2, **CL** - U,An,Ap,C, **KC** - C,P

Module I

Crystal imperfections, phase diagrams and diffusion in solids (18 Hours)

Crystal Imperfections- Point imperfections- geometry of dislocations: Edge Dislocation, Burgers vector, Screw Dislocation-Dislocation motion- Dislocation multiplication- Frank-Read mechanism - Work hardening of metals- Surface imperfections : grain boundary, stacking faults, twin boundary.

Book for study: Book [1], Chapter 6

Phase Diagrams & Diffusion in Solids - The phase rule- Single component system- Binary phase diagrams- Hume Rothery conditions for solid solubility-case of limits solid solubility- Eutectic phase diagram , Eutectic temperature -The Lever rule.

Fick's law and solutions- Applications based on the second law solution- The Kirkendall effect- The atomic model of diffusion

Book for study: Book [1], Chapters 7, 8

Module II

Thin films: Preparation and applications (18 Hours)

Introduction-Nature of thin film-deposition technology-thermal deposition in vacuum - resistance heating– electron beam method - cathodic sputtering-glow discharge sputtering-chemical vapor deposition or vapor plating: thermal decomposition or pyrolysis, vapour phase reaction, vapour transportation method, chemical deposition: electrodeposition, anodic oxidation, electroless plating.

Book for study: Book [2], Chapter 1

Nucleation, film growth and structure- Introduction - Thermodynamics of Nucleation- Nucleation Theories: Capillarity theory ,Atomistic theory , Comparison – stages of film growth – Incorporation of defects during growth - Deposition parameters and grain size – Epitaxy.

Book for study: Book [2], Chapter 1 & 5

Applications of thin films -Qualitative ideas of antireflection coatings, reflection coatings, interference filters, thin film polarizers, beam splitters-optoelectronic applications-photodetectors

Book for study: Book [3], Chapters 2, 3, 4 & 5

Module III

Nanostructured materials: (18 hrs)

Schrodinger equation : particle in a periodic potential, crystal; qualitative ideas on density of states, excitons.

Book for study: Book [4] chapter 1

Nanostructures for electronics: quantum dots, nanowires, 2D nanoelectronics superlattices and heterostructures.

Book for study: Book [8] chapter 9

Synthesis routes: bottom up approaches- PLD, wet chemical; Top down synthesis routes- mechanical alloying.

Book for study: Book [7] Chapter 3

Preparation of Nanoparticles- Nanoparticles through homogeneous nucleation, nanoparticles through heterogeneous nucleation.

Books for study: Book [10] Chapter 3

Special nanomaterials- carbon fullerenes & nanotubes

Book for study: Book [6] Chapter 8

Applications of nanomaterials: Molecular electronics and Nanoelectronics, Nonobots, Biological applications of nanoparticles, band gap engineered quantum devices, nano-mechanics

Book for study: Book [10], Chapter 9

Module IV

Characterization techniques of thin films and nano-structures (18 hours)

Thickness measurement using optical interference method, stylus

Books for study: Book [5] Chapter 3

Optical Characterisation: Transmission and reflectance of single thin film, and multilayer films, Optical Constants: Reflectance methods, Reflectance and transmittance methods and Interferrometric methods and Spectrophotometric methods.

Books for study: Book [5] Chapter 11

X -ray Diffraction (XRD)- Small Angle X-ray Scattering (SAXS) – Scanning Electron Microscopy (SEM) - Transmission Electron Microscopy (TEM) – Atomic Force Microscopy (AFM)

Books for study: Book [7] Chapter 5

Books for study

1. *Materials Science and Engineering: A First Course* – 5th Edition- V. Raghavan (Prentice-Hall of India- 2013)

2. *Thin Film Fundamentals*, A. Goswami, New Age Publishers
3. *Thin Film device applications*, K. L. Chopra and Inderjeet Kaur, Springer, Boston, MA.
4. *Optical properties of Semiconductor nanocrystals*, S. V. Gaponenko, Cambridge University Press
5. *Thin Film Phenomena*, K. L. Chopra, McGraw Hill Book Company.
6. *Introduction to Nanoscience & Technology*, K. K. Chathopadhyay, A. N. Banerjee (Prentice-Hall of India – 2011.)
7. *Textbook of nanoscience and nanotechnology*, B S Murty, P Shankar, Baldev Raj, B B Rath, James Muday- Springer Univ. Press
8. *Introduction to Nanoscience*, S. M. Lindsay, Oxford University Press.
9. *Introduction to Nanotechnology*, Charles P. Poole, Jr. and Frank J. Owens, Wiley, (2003)
10. *Nanostructures and Nanomaterials, Synthesis, properties and applications*, G. Cao, Imperial College Press
11. *Characterization of Semiconductor Heterostructures and Nanostructures*, Edited by Carlo Lamberti, Elseveir, 2008
12. *Textbook of nanoscience and nanotechnology*, B S Murty, P Shankar, Baldev Raj, B. B. Rath, James Muday- Springer Univ. Press
13. *Semiconductor material and device characterization*, Dieter K. Schroder, Wiley-Interscience Publication

BLUE PRINT

MODULE	PART A	PART B	PART C	TOTAL
I	3	2	1	6
II	3	2	1	6
III	2	2	1	5
IV	2	2	1	5
TOTAL	10	8	4	22

Model Question paper

Material Science

Time: 3 hrs, Max.weight: 30

Part A

Short answer Questions (answer any eight questions, each of weight 1)

1. What are grain boundaries?
2. State and explain Gibb's phase rule.
3. What is Kirkendall effect ?
4. Give a brief description of the various evaporation sources used for thin film preparation by resistive heating.
5. Differentiate between heterogeneous and homogeneous nucleation in thin film growth.
6. How does a thin film act as an antireflection coating?
7. What is a quantum dot? Explain its characteristic features.
8. What are superlattices?
9. Briefly explain the working principle of an AFM.
10. How particle size is determined from X-ray diffraction studies?

Part B

Short Essay Questions/Problems (answer any six questions, each of weight 2)

11. Prove that Burgers vector is perpendicular to edge dislocation.
12. Explain lever rule.
13. Explain the various stages in prenucleation of thin film growth.
14. Compare capillarity theory and atomistic theory of nucleation.
15. Discuss the biological applications of nanoparticles.
16. Explain bottom-up approach for the synthesis of nanoparticles with the help of two examples.
17. Briefly explain the working of a stylus thickness profiler.
18. Give an account of band gap determination using UV-Vis spectroscopy

Part C

Long Essay Questions (answer any two questions, each of weight 5)

19. State and explain Fick's laws of diffusion. Derive the equation for diffusion coefficient from Fick's second law.
20. Explain capillarity model of thin film formation.
21. Give an account of a) fullerenes b) carbon nanotubes.
22. Explain the construction and working of transmission electron microscope.

V.9.Semester IV Theory Group B Elective courses

PG4PHYEB03- Photonics

COURSE OUTCOMES(CO):

CO1. Understand and distinguish different optical waveguides and propagation modes, realize the parameters associated with them, perceive the transmission characteristics of optic fibre , infer the various fibre losses,Applying the knowledge in communication technology. **PSO** - PSO2, **CL** - U, Ap,An, **KC** - C,P

CO2. Identify and differentiate the theory behind different types of Laser systems. **PSO** - PSO2, **CL** - U, An, **KC** - F

CO3. Theory behind the nonlinear optical phenomenon and interactions are classified and recognized, different types of phase matching methods are understood. **PSO** - PSO2, **CL** -U,An,Ap, **KC** - C

CO4. Understand the quantum confinement effects , distinguish various quantum confined materials. **PSO** - PSO2, **CL** - U,An,Ap, **KC** - C

Module I

Fiber optics (18 Hours)

Optical fiber waveguides, ray theory transmission – total internal reflection, acceptance angle, numerical aperture, skew rays. Phase and group velocity, phase shift with total internal reflection and the evanescent field, Goos-Hanschen effect. Cylindrical fiber- Step index fibers, graded index fibers. Single mode fibers- cut off wavelengths.

Transmission characteristics of optical fibers- attenuation, material absorption losses in silica glass fibers - intrinsic losses, extrinsic losses, wavelengths for communication. Linear scattering losses- Rayleigh scattering, Mie scattering. scattering losses, nonlinear scattering losses- Stimulated Brillouin scattering, Stimulated Raman scattering, Fiber bend loss, Dispersion - Chromatic dispersion, material and waveguide dispersion.

Book for study: Book [1]

Module II

Quantum Electronics (18 Hours)

Basics of lasers- Population Inversion – Laser pumping- threshold condition (Qualitative ideas only)

Laser systems involving low density media – Ar -ion laser, CO_2 laser, Excimer laser, X-ray laser, FEL

Laser systems involving high gain media – Dye lasers, Solid state lasers– NdYAG laser and Femto second lasers - Ti-Sapphire laser and fiber laser (Qualitative Study only)

Laser diode- Threshold current and power output, Semiconductor lasers- heterojunction lasers, Quantum well lasers

Photodiodes and Avalanche Photodiodes

Books for study: Book [2], [3] & [4]

Module III

Nonlinear optics (18 Hours)

Introduction- nonlinear optical phenomena. Nonlinear optical interactions – second-harmonic generation, sum and difference frequency generation, optical parametric oscillation, third order polarization, Intensity dependent refractive index and self-focussing of light, parametric versus nonparametric process, saturable absorption, two-photon absorption, stimulated Raman scattering

Phase matching - Description of Phase matching, Angle tuning, Temperature Tuning, Types of Phase matching

Books for study: Book [5] ,Chapter 1 & 2, Book [3] , Chapter 16.

Module IV

Nanophotonics (18 Hours)

Foundations of Nanophotonics : Photons and Electrons: Similarities and differences, free space propagation, Confinement of Photons and Electrons, Propagation Through a Classically Forbidden Zone: Tunneling, Localization Under a Periodic Potential: Bandgap, Cooperative Effects for Photons and Electrons.

Nanoscale Optical Interactions, Nanoscale Confinement of Electronic Interactions, Quantum Confinement Effects, Nanoscale Electronic Energy Transfer. Near-Field Interaction-near field optics, near-field microscopy, Aperture less near-field spectroscopy and microscopy

Quantum-Confined Materials: Quantum Wells, Quantum Wires, Quantum Dots, Quantum Rings. Manifestations of Quantum Confinement- Optical Properties, Quantum-Confined Stark Effect. Dielectric Confinement Effect, Quantum Confined Structures as Lasing Media.

Book for study: Book [6]

Books for study

1. Optical Fibre communication - J. M. Senior. Prentice Hall India (1994).
2. Lasers and non-linear optics- B. B. Laud, Second Edition, New Age International (P) Limited.
3. Laser fundamentals - William T. Silfvast, Cambridge University Press, Second Edition (1995).
4. Optoelectronics and photonics: Principles and Practices- S O Kasap, Prentice Hall.
5. Nonlinear Optics – Robert W. Boyd, Academic Press.
6. Nanophotonics: P. N. Prasad, Wiley Interscience (2003).

Books for Reference

1. Quantum Electronics, A. Yariv, John Wiley & Sons
2. Understanding Fiber Optics, J. Hecht, Create Space
3. Photonic Devices, J. M. Liu, Cambridge University Press
4. Modern Optics, B. D. Guenther, Oxford University Press
5. Guided- Wave Optics, C. C. Chen, Wiley

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MODULE	PART A	PART B	PART C	TOTAL
I	3	2	1	6
II	2	2	1	5
III	3	2	1	6
IV	2	2	1	5
TOTAL	10	8	4	22

Model Question paper

Photonics

Time: 3 hrs Max.weight: 30

Part A

Short answer Questions (answer any eight questions, each of weight 1)

1. Derive the relation between numerical aperture and the relative refractive index of a step index fiber.
2. Explain the concept of acceptance angle in an optical fibre. How it is related to numerical aperture?
3. Briefly explain the reasons for pulse broadening due to material dispersion in optical fibres.
4. How does a semiconductor laser work? What are its advantages over other laser systems?
5. Discuss the working of an excimer laser.
6. How is symmetry of a crystal related to optical nonlinearity.
7. What is meant by sum and difference frequency generation.
8. Explain saturable absorption citing its applications.
9. Discuss the cooperative effects for photons and electrons at nanoscale.
10. Describe carrier and particle confinement in a quantum well.

Part B

Short Essay Questions/Problems (answer any six questions, each of weight 2)

11. With the help of energy level diagrams explain the working principle of a CO_2 laser.
12. Write a note on avalanche photodiode.
13. What are the different linear scattering losses in optical fibers. Explain.
14. A multimode step index fiber has a numerical aperture of 0.3 and a core refractive index of 1.45. The material dispersion parameter for the fiber is 250ps which makes material dispersion the totally dominating chromatic dispersion mechanism. Estimate (a) the total rms pulse broadening per kilometer when the fiber is used with an LED source of rms spectal width 50nm and (b) the corresponding bandwidth-length product for the fiber.
15. What is optical rectification? Explain with necessary theory.
16. Explain optical phase conjugation.
17. Derive the expression for energy and density of states for electrons confined in a quantum wire.
18. Discuss the differences and similarities between photons and electrons.

Part C

Long Essay Questions (answer any two questions, each of weight 5)

19. Explain the various types of dispersion in optical fibers and the measures to minimize them.

20. Discuss the construction and working of a quantum well laser.
21. Distinguish between parametric and non-parametric process. Explain any two examples of each process.
22. Discuss the different quantum confined structures and how it is used as lasing media.

PG4PHYEB04- Electronic Communication and Digital Signal Processing

COURSE OUTCOMES(CO):

CO1. To understand the foundations of analog and digital electronic communication systems. **PSO** - PSO2, PSO3, **CL** - U, **KC** - F,P

CO2. To learn the fundamentals of DSP and its mathematical foundations. **PSO** - PSO2, **CL** - U,An, **KC** - F,P

CO3. To comprehend the fundamental ideas of DSP in designing FIR filters. **PSO** - PSO2, **CL** - U, An, Ap, **KC** - C,P

CO4. To comprehend the fundamental ideas of DSP in designing IIR filters. **PSO** - PSO2, **CL** - U, An, Ap, **KC** - C,P

Module I

Analog and Digital Communication (20 Hours)

AM - Need for frequency translation - DSB-SC modulation and demodulation -DSB-C modulator and demodulator - SSB modulator and demodulator

Angle modulation: Phase and frequency modulation - Relationship between Phase and Frequency modulation - Tone modulated FM signal – Bandwidth-Modulation index β - Spectrum of constant bandwidth FM - FM generation byArmstrong's indirect method - FM demodulator - PM modulator and demodulator

PAM - Channel bandwidth - Natural sampling - Flat-top sampling - Equalization- Signal recovery through holding - PWM and PPM

PCM - Quantization - Quantization error - Electrical representation of binarydigits-PCM system - Encoder - Decoder - Companding

Book for study: Book [1]

Module II

Digital Signal Processing (20 Hours)

Basic concepts and applications, Sampling of continuous signal, Signal reconstruction, Anti-aliasing, A-D, D-A conversion – Quantization

Digital signals – Generation - Linear Time Invariant, Casual systems – Difference equations and Impulse responses – Digital convolution

Discrete Fourier Transform – Fourier Series Coefficients of Periodic Digital Signals– Discrete Fourier Transform Formulae - Amplitude and Power spectrum – Spectral estimation using Window functions – Fast Fourier Transform (decimation in frequency, decimation in time)

z transform – Properties – Inverse z transform – Solution of difference equations using the z-transform

Book for study: Book [2]

Additional reference: Book [3]

Module III

Digital filters-FIR filters (16 Hours)

The difference equation and digital filtering – difference equation and transferfunction – The z plane pole zero plot and stability – digital filter frequencyresponse – basic filters – realization of digital filters (direct form I, direct form II)

Finite Impulse Response filters – Fourier transform design – Window method

Book for study: Book [2]

Additional reference: Book [3]

Module IV

Digital filters-IIR filters (16 Hours)

Infinite Impulse Response Filter Design – IIR filter format – Bilinear transformation design method: Analog Filters Using Lowpass Prototype Transformation, Bilinear Transformation and Frequency Warping, Bilinear Transformation Design Procedure-Digital Butterworth and Chebyshev Filters (Characteristics only)

Book for study: Book [2]

Additional reference: Book [3]

Books for study

1. Principles of Communication Systems, Herbert Taub, Donald Schilling, Goutham Saha, Tata Mc Graw Hill
2. Digital Signal Processing, Fundamentals and Applications, Li Tan, Elsevier
3. Digital Signal Processing, S. Salivahanan, Mc Graw Hill Education

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MODULE	PART A	PART B	PART C	TOTAL
I	3	2	1	6
II	3	2	1	6
III	2	2	1	5
IV	2	2	1	5
TOTAL	10	8	4	22

Model Question paper

Electronic Communication and Digital Signal Processing

Time: 3 hrs Max.weight: 30

Part A

Short answer Questions (answer any eight questions, each of weight 1)

1. What is quantization?
2. Explain modulation index in AM.
3. How PAM is generated from continuous signal?
4. What is a Linear Time Invariant system?
5. State sampling theorem.
6. What is Aliasing?
7. Write down the input-output relationship of a FIR filter.
8. Explain impulse response, step response and system response of a digital filter.
9. Distinguish between FIR and IIR filters.
10. Differentiate between Butterworth and Chebyshev filters.

Part B

Short Essay Questions/Problems (answer any six questions, each of weight 2)

11. Discuss the generation of DSB-AM. Derive a relation for its power spectrum.
12. Discuss DSB-AM demodulation.
13. Discuss the FFT Decimation-in-frequency algorithm.
14. A DSP system is described by the difference equation $y(n) = 0.5\ y(n-1) = 5\ (0.2)^n\ u(n)$. Using z-transforms, determine the solution when the initial condition is given by $y(-1) = 1$.
15. Calculate the filter coefficients for a 5-tap FIR band pass filter with a lower cutoff frequency of 2, 000 HZ and a upper cutoff frequency of 2, 400 Hz at a sampling rate of 8, 000 Hz.
16. Discuss how the Window method minimized undesirable Gibbs oscillations in the pass band of a FIR filter.
17. Sketch and explain the mapping of s-plane to z-plane in bilinear transformation.
18. Explain frequency warping.

Part C

Long Essay Questions (answer any two questions, each of weight 5)

19. Discuss the baseband digital PAM and it demodulation.
20. Discuss the following properties of DFT (a) Convolution (b) Time Shifting (c) Conjugate Symmetry.
21. Explain the Fourier series method of designing a FIR filter.
22. Obtain the bilinear transformation formula.

V.10.Semester I Practical course- Credits 3, Hrs 162

PG1PHYP01- General Physics Lab

COURSE OUTCOMES(CO):

CO1. Understand how to apply and verify the theoretical concepts and facts through laboratory experiments. **PSO** - PSO5, **CL** - U, Ap, **KC** - C, F, P

1. Cornu's method of Elliptical fringes/Hyperbolic fringes -elastic constants
2. KMnO4 Absorption spectrum –wavelength using Hartmann's formula
3. Frank-Hertz experiment –ionization potential
4. Hall effect –carrier concentration

5. Four Probe method –resistivity and bandgap
6. pn junction –energy band gap
7. Quincke's method –magnetic susceptibility
8. Michelson interferometer –wavelength difference of sodium lines
9. Ultrasonic grating –compressibility of liquid
10. BH-loop –coercivity, retentivity & energy loss in magnetisation
11. Oscillating disc –viscosity of liquid
12. Thomson's method –specific charge of electron
13. Stefan's law apparatus –verification of the law
14. Millikan's oil drop set up –electric charge of electron
15. Photoelectric effect apparatus –Planck's constant
16. Zeeman effect –Bohr magneton
17. Linear electro optic effect –Half wave voltage
18. GM counter –absorption coefficient
19. Electrical and thermal conductivity –Lorenz number
20. Temperature dependence of capacity –verification of Curie-Wiess law

V.11.Semester II Practical course- Credits 3, Hrs 162

PG2PHYP02- Electronics Lab

COURSE OUTCOMES(CO):

CO1. Understand how to apply and verify the theoretical concepts and facts through laboratory experiments. **PSO** - PSO5, **CL** - U, Ap, **KC** - C, F, P

CO2. Understand and apply the concepts of electronics and micro-electronics in the designing of circuits. **PSO** - PSO3, **CL** - U, Ap, C, **KC**-C, F, P

1. Differential Amplifier using transistor and constant current source –frequency response & CMRR
2. Voltage controlled oscillator design using IC 555
3. RF Oscillator –frequency measurement
4. Differential Amplifier using OP-AMP
5. Low pass & High pass filters –first and second order frequency response & roll off rate
6. Band pass filter using OP-AMP- frequency response and bandwidth
7. Wein bridge oscillator using OP-AMP
8. RC Phase shift oscillator
9. AM generation & demodulation

10. Solution of differential equation using IC 741
11. Current to Voltage and Voltage to Current conversion using IC 741
12. Triangular wave generator using OP-AMP
13. OP-AMP parameters –open loop gain, offset voltage, open loop response
14. D/A convertor using IC 741
15. Response of IF tuned amplifier

V.12.Semester III Practical course- Credits 3, Hrs 162

PG3PHYP03- Computational Physics Lab

COURSE OUTCOMES(CO):

CO1. Understand how to apply and verify the theoretical concepts and facts through laboratory experiments. **PSO** - PSO5, **CL** - U, Ap**, KC** - C, F, P

CO2. Understand the fundamentals of Programming and numerical techniques to apply it to solve theoretical problems. **PSO** - PSO4, **CL** - U, Ap, C, **KC** - C, P

1. MATLAB program for finding the roots of a non-linear polynomial equation by bisection method
2. MATLAB program to generate interference pattern of Young's experiment
3. MATLAB program for Gaussian integration for n=2
4. MATLAB program for studying the variation of magnetic field with temperature in superconductors
5. MATLAB program for plotting the trajectory of a particle in Rutherford scattering
6. MATLAB program to integrate a function using Trapezoidal rule
7. MATLAB program for integrating a given function using Simpson's 1/3 rule
8. MATLAB program for solving a set of two linear equations in two variables using Gauss elimination
9. MATLAB program to study the motion of a sphere falling through a viscous medium
10. MATLAB program to plot the wavefunction of particle in one dimensional box
11. MATLAB program to calculate the probability of penetration of a barrier by a particle
12. MATLAB program to plot the trajectory of a charged particle in an electrostatic field

V.13.Semester IV Practical courses- Credits 3, Hrs 162

I.Theoretical Physics

PG4PHYEAP01- Special Computational Physics Lab

COURSE OUTCOMES(CO):

CO1. Understand how to apply and verify the theoretical concepts and facts through laboratory experiments. **PSO** - PSO5, **CL** - U, Ap, **KC** - C, F, P

CO2. Understand the fundamentals of Programming and numerical techniques to apply it to solve theoretical problems. **PSO** - PSO4, **CL** - U, Ap, C, **KC** - C, P

1. PYTHON program for the simulation of trajectory of a body fired at an angle φ with the horizontal with the velocity u
2. PYTHON program for the phase trajectory of the bob of simple pendulum
3. PYTHON program for the trajectory of alpha particle in Rutherford scattering
4. PYTHON program to simulate planetary orbit around Sun
5. PYTHON program for logistic map-bifurcation
6. PYTHON program for the phase trajectory of a damped harmonic oscillator
7. PYTHON program to solve Lorenz system using Runge-Kutta method
8. PYTHON program to plot Lorenz attractor
9. PYTHON program to plot Julia set
10. PYTHON program for calculating the Lyapunov exponent of logistic map
11. PYTHON program to study resonance in series LCR circuit
12. PYTHON program for the eigen states of a particle trapped in a one dimensional potential well
13. PYTHON program for the phase-plot of Duffing oscillator
14. PYTHON program to plot Mandelbrot set
15. PYTHON program to study the band structure of Kronig-Penney model

II.Applied Physics

PG4PHYEBP01- Applied Physics Lab- Credits 3, Hrs 162

COURSE OUTCOMES(CO):

CO1. Understand how to apply and verify the theoretical concepts and facts through laboratory experiments. **PSO** - PSO5, **CL** - U, Ap, **KC** - C, F, P

CO2. Understand and apply the concepts of electronics, micro-electronics and digital signal processing in the designing of circuits. **PSO** - PSO3, **CL** - U, Ap, C, **KC** - C, F, P

CO3. Understand and realise a few applications of the concepts of photonics. **PSO** - PSO3, **CL** - U, Ap, C, **KC** - C, F, P

CO4. Understand and apply the techniques of material science of synthesis of materials. **PSO** - PSO3, **CL** - U, Ap, C, **KC** - C, F, P

A. Solid state semiconductor device physics and microelectronics

1. Design and construct a DC voltmeter using FET
2. Design and construct a DC voltage regulator using transistors and Zener diode. Study the line and load regulation characteristics for suitable o/p voltage and maximum load current.
3. Design and construct a differential amplifier using transistors. Study frequency response and measure input, output impedances. Also measure CMRR of the circuit.
4. Design and construct a Darlington pair amplifier using medium power transistors for a suitable output current. Study the frequency response of the circuit and measure the input and output impedances.
5. (a) Design and construct a single stage transistor amplifier circuit with 5% / 10% / 20% negative feedback. Study the frequency response and determine the bandwidth and gain-bandwidth product (b) Measure the input and output impedances of the circuit with and without feedback and study the changes in gain, bandwidth, input and output impedances introduced by the feedback.
6. Study the V-I characteristics of a JFET. Determine pinch-off voltage, saturation drain current and cut-off voltage of the device.
7. Design and construct a low frequency common source amplifier using JFET. Study the frequency response, measure the input and output impedances.
8. Obtain the steady output side characteristics and transfer characteristics of the given MOSFET for a specified value of gate-source voltage.
9. Obtain the steady output side characteristics and transfer characteristics of the given IGBT for a specified value of gate-source voltage.
10. Study the switching characteristics of a MOSFET and IGBT and determine the timing parameters.
11. Write and execute a program to store the given set of ten numbers in the ascending order. Modify the program to arrange the numbers in the descending order. Use PC or 8051kit.

12. Write a program to find the largest of the numbers in the array of memory and store the result in a given memory location. Modify the program to find the smallest of the numbers in an array of memory. Use PC or 8051 kit.
13. Generate sine and square waves of different periods using a microcontroller 8051.

B. Electronic communication and Digital signal processing

1. Measure and plot the radiation pattern of a Horn antenna.
2. Measure the characteristic impedance and transmission line parameters of a coaxial cable.
3. VSWR Measurement: Determine the Voltage Standing Wave Ratio and Reflection Coefficient of a slotted waveguide
4. Linear and Circular Convolution of two given sequences: Write a MATLAB code to perform linear and circular convolution of two given discrete time signals using (a) CONV function in MATLAB (b) Convolution Sum formula.
5. Design and Implementation of FIR filter: Design an IIR filter that meet the following specification using Hamming window in MATLAB. Window length, N = 27, Stop band attenuation = 50 dB, Cut-off frequency = 100 Hz, Sampling frequency = 1000 Hz.
6. Design and Implementation of IIR filter: Design an IIR filter in MATLAB with pass band edge frequency 1500 Hz and stop band edge at 2000 Hz for a sampling frequency of 8000 Hz, variation of gain within pass band 1 dB and stop band attenuation of 15 dB. Use Butterworth prototype design and bilinear transformation.
7. Design and Implementation of IIR filter: Design an IIR filter in MATLAB with pass band edge frequency 1500 Hz and stop band edge at 2000 Hz for a sampling frequency of 8000 Hz, variation of gain within pass band 1 dB and stop band attenuation of 15 dB. Use Chebyshev prototype design and bilinear transformation.
8. Give the necessary theory and circuit diagram of Pulse Amplitude and Pulse Width Modulations. Construct the circuit and sketch the input and output waveforms.
9. Give the necessary theory and circuit diagram of an electronic circuit that use IC CD4046 to demonstrate Frequency modulation and demodulation. Construct the circuit and sketch the input and output waveforms.
10. Give the necessary theory and circuit diagram of an electronic circuit that use IC 7432 to realize a Multiplexer and demultiplexer. Construct the circuit and record the output.
11. Construct a voltage to frequency converter with a maximum output of 10kHz and study the output frequency as a function of input voltage. Modify the circuit to increase the output frequency to 30 kHz.
12. Construct a frequency to voltage converter and study the output voltage as a function of the input frequencies. Repeat the experiment for both sine wave and square wave input.

13. Characterize the given phase locked loop and hence find the capture range and lock range. Repeat the experiment by changing the free running frequency.
14. Setup a frequency multiplier using PLL IC 4046 to multiply the input frequency by factors 10, 6 and 8.
15. Design and construct a frequency modulator for sinusoidal signal using IC 555 for given input signal voltages and frequencies. Measure the modulation index in each case.
16. D/A convertor circuits using OP Amp 741

C.Photonics

1. Characteristics of photo diode, photo transistor, LDR, LED - Determination of the relevant parameters.
2. Beam Profile of laser, spot size and divergence.
3. Temperature co-efficient of resistance of copper.
4. Data transmission and reception through optical fiber link.
5. Magneto-optic effect (Faraday effect) – Verdet’s constant.
6. Study of Emission spectra of metals using constant deviation spectrometer.
7. Identification of elements of an alloy using arc and constant deviation spectrometer.
8. Solar cell characteristics
9. Bending laws of an optical fiber
10. Numerical aperture of an optical fiber
11. Diffraction of light by Cross wire and wire mesh - laser
12. Diffraction of light by single slit and double slit - laser

D.Material science

1. Ultrasonic Interferometer – ultrasonic velocity in liquids
2. Ultrasonic Interferometer – Young’s modulus and elastic constant of solids
3. Dielectric constant of a substance - resonance method
4. Determination of forbidden energy gap
5. Determination of Fermi energy of copper
6. Study of ionic conductivity in KCl / NaCl crystals
7. Thermo emf of bulk samples of metals (aluminium or copper)
8. Study of physical properties of crystals (specific heat, thermal expansion, thermal conductivity, dielectric constant)
9. Study of variation of dielectric constant of a ferro electric material with temperature (barium titanate)
10. Study of variation of magnetic properties with composition of a ferrite specimen

11. Four probe method – energy gap
12. Energy gap of Ge or Si
13. Thin film coating by polymerisation
14. Measurement of thickness of a thin film
15. Study of dielectric properties of a thin film
16. Study of electrical properties of a thin film (sheet resistance)
17. Growth of single crystal from solution and the determination of its structural, electrical and optical properties (NaCl, KBr, KCl, NH4Cl etc.)
18. Determination of lattice constant of a cubic crystal with accuracy and indexing the Bragg reflections in a powder X-ray photograph of a crystal
19. Observation of dislocation – etch pit method
20. Michelson Interferometer – Thickness of transparent film
21. X-ray diffraction – lattice constant
22. Optical absorption coefficient of thin films by filter photometry
23. Temperature measurement with sensor interfaced to a PC or microprocessor
24. ESR spectrometer – g factor
25. Beam profile of diode laser
26. Track width of a CD using laser beam
27. He–Ne laser verification of Malus law, measurement of Brewster angle, refractive index of a material
28. IR spectrum of few samples
29. Strain gauge – Y of a metal beam

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