KANNUR UNIVERSITY

(Abstract)

New Generation Course in affiliated Colleges-M.Sc. Physics with Computational and Nano Science Specialization programme under CBSS - Scheme, Syllabus and pattern of question papers of Core Course with modified Course Codes- Implemented w.e.f 2020-21 admission- Orders issued

ACADEMIC C SECTION

Acad/C2/16580/NGC/2021 Dated: 26.10.2021

Read:-1. U.O No Acad/C2/16580/NGC/2021 dated 20.01.2021
2. U.O Note No. EX/EG-1-1/21498/PG/Oct2020 dated 14.09.2021
3. Letter No, Acad C2/2408/2020 dated 24.09.2021
4. Minutes of the meeting of Board of Studies in Physics (PG) held on 29.09.2021
5. Order of the Vice Chancellor dated 20.10.2021

ORDER

1.As per paper read (1) above, Scheme, Syllabus and model question papers of Core Course of M.Sc. Physics with Computational and Nano Science Specialization programme(New Generation Programme) under CBSS was implemented.

2.Meanwhile, the Examination Branch, as per the paper read as (2) above, pointed out the practical difficulty in conducting Examinations for the aforesaid M.Sc.Physics with Computational and Nano Science Specialization, as its Course Code is same as that of the conventional M.Sc. Physics programme.

3.Subsequently, vide paper read (3) above, the Board of Studies in Physics (PG) was entrusted to modify the Course Code of the M.Sc. Physics with Computational and Nano Science Specialization programme.

4.Accordingly, the Board of Studies in Physics (PG), resolved to change the Course Codes of the M.Sc. Physics with Computational and Nano Science Specialization programme by replacing the prefix PHY with PHYCN. Further, the Chairperson of the Board of Studies Physics (PG) submitted the Syllabus of the M.Sc.Physics with Computational and Nano Science Specialization programme after modifying the Courses Codes, as per the paper read (4)above.

5.The Vice Chancellor, after considering the matter in detail and in exercise of the powers of Academic Council conferred under Section 11(1) Chapter III of Kannur University Act 1996, accorded sanction to implement the Scheme, Syllabus and model question paper of the Core Course of the M.Sc. Physics with Computational and Nano Science Specialization programme (CBSS),*(with modified Course Codes)* at Govt.College, Kasaragod, with effect from 2020-21 admission, subject to reporting to the Academic Council.

6.The modified Scheme, Syllabus and model question paper of the Core Course of M.Sc. Physics with Computational and Nano Science Specialization programme (CBSS), applicable w.e.f 2020-21admission,),(with modified Course Codes) are uploaded in the University website (www.kannuruniversity.ac.in).

7.The U. O read as paper (1) above stands modified to this extent.

Orders are issued accordingly.

Sd/-
BALACHANDRAN V K
DEPUTY REGISTRAR (ACAD)
For REGISTRAR

To: The Principal
Govt. College
Kasaragod

Copy To: 1. The Examination Branch (through PA to CE)
2. PS to VC/PA to PVC/PA to Registrar
3. DR/ARI Academic
4. The Web Manager (for uploading in the website)
5. SF/DF/FC

KANNUR UNIVERSITY CIVIL STATION P.O. KANNUR Pin-670 002 THAVAKKARA

Forwarded / By Order
SECTION OFFICER

KANNUR UNIVERSITY

M.Sc. PHYSICS

with

Computational & Nano Science specialization

DEGREE SYLLABUS

FOR

CREDIT BASED CURRICULUM

2020

Preamble

About the Programme

M.Sc. Physics with Computational and Nano Science specialization is a two-year programme that inculcates a comprehensive perception about the real world application of Physics. The main objective of this programme is to develop an understanding of pure and applied Physics through theoretical and practical approaches and hence build inspired research in allied fields. This programme covers advanced knowledge of specialisations like Computational and Nano Science and provides insight in experimental techniques and scientific documentation & presentation. It includes a unique academic curriculum and ensures the transfer of knowledge through project-based learning.

Programme Outcome

PSO1: Master fundamentals of physics and apply the knowledge gained in the area of nano science.

PSO2: Master computational techniques used in modern scientific research and development in the fields of physics and nanoscience.

PSO3: Develop own capabilities in experimental design and instrumentation techniques in the field of Nano Science.

PSO4: Develop the capability for extensive literature review in science and interdisciplinary areas; Master the art of effective technical presentations; Produce high quality research papers in peer reviewed journals and symposia.

The duration of the M. Sc. Physics with Computational & Nano Science specialization (CCSS) shall be 2 (two) years. This programme consists of 15 (fifteen) theory courses, 2 (two) mixed courses, 4 (four) lab courses, 1 (one) project work, and 1 (one) general viva-voce. A student can earn 16 (sixteen) credits in first, 23 (twenty three) credits in second semester, 24 (twenty four) credits in third semester, and 17 (seventeen) in the fourth semester and a total of 80 (eighty) credits in four semesters. Indirect grading patterns for internal and external marks will be followed.

Theory and mixed courses:

- There are 12 (twelve) core courses:
    - Semester I, and Semester II will have 4 (four) core courses, and Semester III will have 3 (three) core courses and Semester IV will have 1 (one) core course.
- There are 2 (two) special courses, and 1 (one) elective course with focus on Computational and Nano Science in the programme.
    - 2 (two) special courses will come in Semester III.
    - 1 (one) elective course will come in Semester IV.
- 1 (one) course on experimental techniques with a strong focus on activity oriented learning in the first and second semesters.
- 1 (one) course on scientific documentation and presentation in the fourth semester.

Practical Courses:

The first two semesters will have two courses on laboratory practical. The third semester will have two courses on laboratory practical. Each course has a credit of 3 (three). Minimum number of experiments specified in each course should be done and recorded. The practical examination will be conducted at the end of the second and third semesters at the University level by two examiners (one internal and the other external). The duration of the examination will be 5 (five) hours.

Project Work and Field Visit:

In fourth semester there will be a project with credit 7 (seven). The project should be very relevant and innovative in nature. It should be aimed to motivate the inquisitive and research aptitude of the students. The student will devote part of fourth semester on a project work related to a relevant area either in the Department or in collaboration with an industrial/research/ academic institution. or other Department/University/Institution). The type of the project can be decided by the student and the guide (a faculty of the Department

Students should be encouraged to undergo the project at established research centres, universities or industry. The time spent at external centres should be treated as equivalent to attending the parent institution. Students may be encouraged to publish their project dissertation in peer-reviewed journals or conferences.

For the conduction of the project work sufficient span of time will be allotted for the students and its evaluation will be scheduled at the end of the fourth semester. External evaluation of the project will be conducted by two external examiners appointed by the University at the end of the fourth semester. Field visit should be arranged to enrich the project work. The distribution of credits is as follows: 4 for the Project Work and Field Visit, and 3 for the Project Report.

General Viva-Voce:

An external viva-voce will be conducted by two external examiners appointed by the University at the end of the fourth semester. The viva-voce examination will evaluate the student's overall understanding of the knowledge gained during the MSc Programme. There shall be 2 (two) credits for the viva-voce.

Admission and Examinations:

Eligibility for admission will be as per the rules laid down by the University from time to time. The course shall be offered in four semesters within a period of two academic years. The applicant must be holder of a Bachelor's degree in physics, with mathematics, computer science or chemistry as complementary/ minor subjects.

Examination of the theory courses will be conducted at the end of each semester. Examination for the I and II semester practical courses will be conducted at the end of second semester. Practical Examination for III Semester will be conducted at the end of III Semester. A 7-point indirect relative grading system is to be followed. Seminar for Continuous Assessment (CA) is to be conducted for each course, separately.

1. The schemes and syllabus shall come into effect from 2020 admission onwards.

2. The minimum duration for completion of a two year M.Sc. Physics with Computational and Nano Science specialization is four semesters. The maximum period for completion is eight semesters (4 years). The duration of each semester shall be five months inclusive of examinations. There shall be at least 90 instructional days and a minimum of 450 instructional hours in a semester. Semesters I and III shall be from June to October and semesters II and IV shall be from November to March.
3. The total marks for the programme is 1500.
4. The students admitted to the P.G. programme shall be required to attend at least 75% of the total number of classes (theory/practical) held during each semester. The students having less than prescribed percentage of attendance shall not be allowed to appear for the University examination. The following will be the distribution marks for attendance in the internal evaluation.

Attendance	**% of marks for attendance**
Above 90% attendance	100
85 to 89%	80
80 to 84 %	60
76 to 79 %	40
75 % 20	20

Condonation of shortage of attendance to a maximum of 12 days of the working days in a semester subject to a maximum of two times during the whole period of post graduate programme may be granted by the Vice- Chancellor of the University. Benefit of Condonation of attendance will be granted to the students on health grounds, for participating in University Union activities, meeting of the University bodies and participation in other extracurricular activities on production of genuine supporting documents with the recommendation of the Head of the Department concerned. A student who is not eligible for such condonation **shall repeat the course** along with the subsequent batch. Students who complete the courses and secure the minimum required attendance for all the courses of a semester and register for the university examinations at the end of the semester alone will be promoted to higher semester.

5. The evaluation scheme for each course (including projects) shall contain two parts; (a) Continuous Assessment (CA) and (b) End Semester Evaluation (ESE). 20% marks shall be given to CA and the remaining 80% to ESE. The ratio of marks between internal and external is 1:4 excluding experimental techniques, project, and viva-voce. The Project Work and Field Visit course (PHYCN4Pr01) will have a mark ratio 2:3. Experimental Techniques (PHYCN2C05), Scientific Documentation and Presentation (PHYCN4C16) will have only internal evaluation. General Viva-Voce (PHYCN4C17) will have no internal evaluation.

CONTINUOUS ASSESSMENT (CA):

Theory

	Components	% of marks for
i	Two test papers	40
ii	Assignments/Book review/debates	20
iii	Seminars/Presentation of case study	20
iv	Attendance	20

Practical

	Components	% of marks
i	Two test papers	40
ii	Lab skill	20
iii	Records / viva	20
iv	Attendance	20

To ensure transparency of the evaluation process, the internal assessment marks 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. There shall not be any chance for improvement for internal marks. The course teacher shall maintain the academic record of each student registered for the course, which shall be forwarded to the University, through the college Principal, after endorsed by the Head of the Department.

TEST

For each course there shall be at least two class tests during a semester. The probable dates of the tests shall be announced at the beginning of each semester. Marks should be displayed on the notice board. Valued answer scripts shall be made available to the students for perusal within 10 working days from the date of the tests.

ASSIGNMENT

Each student shall be required to do 2 assignments for each course. Assignments after valuation must be returned to the students. The teacher shall define the expected quality of the above in terms of structure, content, presentation etc. and inform the same to the students. Punctuality in submission is to be considered.

SEMINAR

Every student shall deliver one seminar as an internal component for every course and must be evaluated by the respective course teacher in terms of structure, content, presentation and interaction. The soft and hard copies of the seminar report are to be submitted to the teacher in charge.

All the records of **Continuous Assessment (CA**) must be kept in the department and must be made available for verification by university. The

results of the CA shall be displayed on the notice board within 5 working days from the last day of a semester. It should be signed by the candidates.
The marks awarded for various components of the CA shall not be rounded off, if it has a decimal part. The total marks of the CA shall be rounded off to the nearest whole number.

END SEMESTER EVALUATION (ESE):

There shall be a **double valuation system** of answer books. The average of two valuations shall be taken into account. If there is a variation of more than 10% of the maximum marks, the answer books shall be valued by a third examiner. The final marks to be awarded shall be the **average of the nearest two** out of three awarded by the examiners. After that there shall be no provision for revaluation.

End Semester Evaluation in Practical courses shall be conducted and evaluated by **two examiners- one internal and one external.** Duration of practical external examinations shall be decided by the Board of Studies concerned.

PROJECT WORK:

There shall be a project work with Dissertation to be undertaken by all students. The Dissertation entails field work, lab work, report, presentation and viva voce. The class hours allotted for project work may be clustered into a single slot so that students can do their work at a centre /location for a continuous period of time. However, appropriate changes can be made by the concerned Board of studies in this regard. The Project Report will be evaluated separately, and will be given 3 (three) credits after evaluation by external evaluators at the end of semester IV.

Project work shall be carried out under the supervision of a teacher in the parent department concerned or prescribed by the department coordinator. A candidate may, however, in certain cases be permitted to work on the project in an industrial/ research organization on the recommendation of the Head of the Department/ Department Coordinator. In such cases, one of the teachers from the department concerned would be the supervisor/internal guide and an expert from the industry/ research organization concerned shall act as co-supervisor/ external guide. Periodic evaluation of the project work should be held and the progress will be used for continuous evaluation for the Project Work.

The project report shall be prepared according to the guidelines approved by the university. Two typed copies of the project report shall be submitted to the Head of the Department, two weeks before the commencement of the ESE of the final semester.

Every student has to do the project work independently. No group projects are accepted. The project should be unique with respect to title, project content and Project layout. No two project reports of any student should be identical, in any case, as this may lead to the cancellation of the project report by the university.

Evaluation of Project work:

a)

1. The ESE of the project work shall be conducted by two external examiners.
2. Evaluation of the Project Report shall be done under mark System.
3. The evaluation of the project will be done at two stages:

a. Continuous/Internal Assessment (CA) (supervising teacher/s will assess the project and award internal marks).

b. External evaluation (by external examiners appointed by the University).

4. Marks secured for the project will be awarded to candidates, combining the internal and external marks.
5. The internal to external component is to be taken in the ratio 1:4 for all courses except for Project Work (PHYCN4Pr01) for which it will be 2:3.
6. Assessment of different components of project may be taken as below:

Internal 40% of total	
Punctuality	20
Literature Review	20
Use of Data	20
Mid Semester Evaluation*	20
Presentation and Viva-voce*	20

*Evaluation by a three member college-level committee.

External (60% of the total)	
Novelty of the topic	5
Statement of Objectives	10
Experimental Design/ Theoretical Framework	15
Data and Analysis	30
Results and Outlook	10
Project Report	15
Presentation and Viva-Voce	15

7. External Examiners will be appointed by the University from the list of IV semester Board of Examiners in consultation with the Chairperson of the Board.
8. Internal Assessment should be completed 2 weeks before the last working day of IV semester.
9. Internal Assessment marks should be published in the department.
10. Chairman Board of Examinations, may at his discretion, on urgent requirements, make certain exceptions in the guidelines for the smooth conduct of the evaluation of the project.

PROJECT REPORT

The project dissertation should be ready for peer-review and certified plagiarism free.

1. Structure of the Project Report should have the following structure:

1. Cover page and Title page
2. Bonafide certificate/s
3. Declaration by the student
4. Acknowledgement
5. Table of contents
6. List of tables
7. List of figures
8. List of symbols, Abbreviations and Nomenclature
9. Chapters
10. Appendices
11. References

2. Page dimension and typing instruction

The dimension of the Project report should be in A4 size. The project report should be printed in bond paper and hard bound. The general text of the report should be typed with 1.5 line spacing. The general text shall be typed in the font style 'Times New Roman' and font size 12. Paragraphs should be arranged in justified alignment with margin 1.25'' each on top. Portrait orientation shall be there on Left and right of the page. The content of the report shall be a minimum of 40 pages and certified for plagiarism free.

PASS CONDITIONS:

Submission of the Project report and presence of the student for viva are compulsory for internal evaluation. For external evaluation the Project report submitted by the student shall be evaluated by the external examiners. No marks shall be awarded to a candidate if she/he fails to submit the Project report for external evaluation.

1. The student should get a minimum of 40% marks for passing in the project. In an instance of inability of obtaining a minimum of 40% marks, the Project work may be redone and the report may be resubmitted along with subsequent examinations through the parent department.
2. There shall be no improvement chance for the marks obtained in the Project Report.

VIVA VOCE:

The Viva voce shall be conducted by two examiners. For external viva, both of them shall be **external examiners.** Appearance of **CA** and **ESE** are compulsory and no marks shall be awarded to a candidate if absent for CA/ESE or both.

GRADING SYSTEM:

Seven Point Indirect Relative grading system:

Evaluation (both internal and external) is carried out using the Mark system. The grading on the basis of a total internal and external marks will be indicated for each course and for each semester and for the entire programme.

The guidelines of grading is as follows-

Table 1

Percentage of Marks (CA+ESE)	Grade	Interpretation	Range of Grade Points	Class
90 and above	O	Outstanding	9 - 10	First class with Distinction
80 to below 90	A	Excellent	8 - 8.9	
70 to below 80	B	Very good	7 - 7.9	First class
60 to below 70	C	Good	6 - 6.9	
50 to below 60	D	Satisfactory	5 - 5.9	Second class
40 to below 50	E	Pass/ Adequate	4 - 4.9	Pass
Below 40	F	Failure	0 - 3.9	Fail

$$SGPA = \frac{SUM\ OF\ CREDIT\ POINTS\ OF\ ALL\ COURSES\ IN\ THE\ SEMESTER}{TOTAL\ CREDITS\ IN\ THAT\ SEMESTER}$$

$$\text{Credit point} = \text{Grade point } (G) \text{ X credit}$$

$$CGPA = \frac{Sum\ of\ credit\ points\ of\ all\ completed\ semesters}{Total\ credits\ acquired}$$

$$OGPA = \frac{SUM\ OF\ CREDIT\ POINTS\ OBTAINED\ IN\ FOUR\ SEMESTERS}{TOTAL\ CREDITS\ (80)}$$

PASS REQUIREMENT:

COURSE:

A candidate securing **E grade with 40% of aggregate marks and 40% separately** for **ESE** for each course shall be declared to have passed in that course.

SEMESTER

Those who secure not less than 40% marks (both ESE and CA put together) for all the courses of a semester shall be declared to have successfully completed the semester.The marks obtained by the candidates for CA in the first appearance shall be retained (irrespective of pass or fail).

The candidates who fail in theory unit shall reappear for theory unit only, and the marks secured by them in practical unit, if passed in practical, will be retained.

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

For the successful completion of a semester, a candidate should pass all courses and secure a minimum SGPA of 4. However a student is permitted to move to the next semester irrespective of his/her SGPA. A student will be permitted to secure a minimum SGPA of 4.00 required for the successful completion of a Semester or to improve his results at ESE of any semester, by reappearing for the ESE of any course of the semester concerned, along with the examinations conducted for the subsequent admission

IMPROVEMENT:

A candidate who secures minimum marks (40%) for a pass in a course will be permitted to write the same examination along with the next batch if he/she desires to improve his/her performance in ESE. If the candidate fails to appear for the improvement examination after registration, or if there is no change/up gradation in the marks after availing the improvement chance, the marks obtained in the first appearance shall be retained. There shall be no improvement chance for the marks obtained in internal assessment. Improvement of a particular semester can be done only once. The student shall avail the improvement chance in the succeeding year along with the subsequent batch.

There will be no supplementary examinations. For re-appearance/ improvement students can appear along with the next batch.

CREDIT DISTRIBUTION:

Each course shall have certain credits. For passing the programme the student shall be required to achieve a minimum of 80 credits. The Board of studies can distribute the credits for different courses subjected to a total maximum of 80.

AWARD OF DEGREE:

The successful completion of all the courses prescribed for the Post Graduate degree programme with E grade (40 % of maximum marks) and with a minimum SGPA of 4.0 for all semesters and minimum CGPA 4.0 satisfying minimum credit 80, shall be the minimum requirement for the award of degree. Position certificates up to third position will be issued on the basis of highest marks secured for the programme. In the case of a tie, the highest CGPA is to be considered.

TOUR/ FIELD VISIT:

Study tours to educational and scientific institutions may be conducted. No credit shall be assigned to it. The field visit will be considered as part of the Project Work.

SYLLABUS

COURSES IN VARIOUS SEMESTERS

SEMESTER I (16 Credits)

1. PHYCN1C01: MATHEMATICAL PHYSICS I (4C)
2. PHYCN1C02: CLASSICAL MECHANICS (4C)
3. PHYCN1C03: ELECTRODYNAMICS (4C)
4. PHYCN1C04: ELECTRONICS (4C)
5. PHYCN1P01: PRACTICAL - I (No Credits)
6. PHYCN1P02: PRACTICAL - II (No Credits)
7. PHYCN1C05: EXPERIMENTAL TECHNIQUES (No Credits)

SEMESTER II (23 Credits)

1. PHYCN2C06: QUANTUM MECHANICS I (4C)
2. PHYCN2C07: MATHEMATICAL PHYSICS II (4C)
3. PHYCN2C08: STATISTICAL MECHANICS (4C)
4. PHYCN2C09: SPECTROSCOPY (4C)
5. PHYCN2P01: PRACTICAL - I (3C)
6. PHYCN2P02: PRACTICAL - II (3C)
7. PHYCN2C05: EXPERIMENTAL TECHNIQUES (1C)

SEMESTER III (24 Credits)

1. PHYCN3C10: QUANTUM MECHANICS II (4C)
2. PHYCN3C11: SOLID STATE PHYSICS (4C)
3. PHYCN3C12: NUCLEAR AND PARTICLE PHYSICS (4C)
4. PHYCN3C13: PHYSICS AT NANOSCALE (3C)
5. PHYCN3C14: COMPUTATIONAL PHYSICS (3C)
6. PHYCN3P03: PRACTICAL III – NANOSCIENCE LAB (3 Credits)
7. PHYCN3P04: PRACTICAL IV – COMPUTATIONAL PHYSICS LAB (3 Credits)

SEMESTER IV (17 Credits)

1. PHYCN4C15: OPTICS (4C)
2. PHYCN4E01-03: ELECTIVE COURSE – (3C)
3. PHYCN4C16: SCIENTIFIC DOCUMENTATION AND PRESENTATION (1C) (MOOC)
4. PHYCN4Pr01: PROJECT WORK AND FIELD VISIT (7C)
5. PHYCN4C17: GENERAL VIVA-VOCE (2C)

ELECTIVE COURSES

1. One among the following:
   a. PHYCN4E01: CRYSTAL GROWTH, THIN FILMS AND CHARACTERIZATION
   b. PHYCN4E02: NANO OPTICS
   c. PHYCN4E03: ADVANCED COMPUTATIONAL PHYSICS

Credit and mark distribution for various courses

Semester	Course Code	Title	Marks			Credit	Hours/ Week
			Int	Ext	Total		
I	PHYCN1C01	Mathematical Physics I	15	60	75	4	4
	PHYCN1C02	Classical Mechanics	15	60	75	4	4
	PHYCN1C03	Electrodynamics	15	60	75	4	4
	PHYCN1C04	Electronics	15	60	75	4	4
	PHYCN1P01	Practical - I	----	----	----	----	4
	PHYCN1P02	Practical - II	----	----	----	----	4
	PHYCN1C05	Experimental Techniques	----	----	----	----	1
Semester I Total			60	240	300	16	25
	PHYCN2C06	Quantum Mechanics I	15	60	75	4	4

II	PHYCN2C07	Mathematical Physics II	15	60	75	4	4
	PHYCN2C08	Statistical Mechanics	15	60	75	4	4
	PHYCN2C09	Spectroscopy	15	60	75	4	4
	PHYCN2P01	Practical - I	12	48	60	3	4
	PHYCN2P02	Practical - II	12	48	60	3	4
	PHYCN2C05	Experimental Techniques	10	0	10	1	1
Semester II Total			**94**	**336**	**430**	**23**	**25**
III	PHYCN3C10	Quantum Mechanics II	15	60	75	4	4
	PHYCN3C11	Solid State Physics	15	60	75	4	4
	PHYCN3C12	Nuclear and Particle Physics	15	60	75	4	4
	PHYCN3C13	Physics at Nanoscale	12	48	60	3	3
	PHYCN3C14	Computational Physics	12	48	60	3	3
	PHYCN3P03	Practical - III	12	48	60	3	4
	PHYCN3P04	Practical - IV	12	48	60	3	3
Semester III Total			93	372	465	24	25
	PHYCN4C15	Optics	15	60	75	4	4

IV	PHYCN4E01-03	Elective Course	12	48	60	4	4
	PHYCN4C16	Scientific Documentation and Presentation	20	0	20	1	2
	PHYCN4Pr01	Project Work and Field Visit	40	60	100	7	15
	PHYCN4C17	General Viva-Voce	0	50	50	2	0
Semester IV Total			87	218	305	17	25
Programme Total			334	1166	1500	80	100

Note: - PHY-Physics, CN-Computational and Nano science, C-Core Course, P-Practical, E–Elective Course, Pr-Project

Question paper pattern

PHYCNXXXX…………………………………………………………

Time: 3 Hrs. **Maximum marks: 60**

(Instructions to question setters: Questions should be framed from all modules following a uniform distribution.)

Section A

(Answer any two)

1. a) Essay question from one or more modules (Don't repeat the same module again in this section)

Or

b) Essay question from one or more modules (Don't repeat the same module again in this section)

2. a) Essay question from one or more modules (Don't repeat the same module again in this section)

Or

b) Essay question from one or more modules (Don't repeat the same module again in this section)

(2 x 12 =24 Marks)

Section B

(Answer any four. 1 Mark for Part a; 3 marks for Part b; 5 marks for Part c)

3. a) Direct type question (to test knowledge acquired)

   b) Understanding type

   c) Problem type (Ability to synthesize knowledge or critical evaluation of knowledge)

4. a)…………………………………………
   b)………………………………………..
   c)…………………………………………
5. a)…………………………………………
   b)………………………………………..
   c)…………………………………………
6. a)…………………………………………
   b)………………………………………..
   c)…………………………………………
7. a)…………………………………………
   b)………………………………………..
   c)…………………………………………
8. a)…………………………………………
   b)………………………………………..
   c)…………………………………………

(4X9=36 Marks)

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DETAILED SYLLABUS

SEMESTER I

PHYCN1C01 MATHEMATICAL PHYSICS I

(Contact hours -72 hrs;Max. Ext. Marks: 60; Max.Int.Marks:15 Credit 4)

Module I

Matrices: Orthogonal matrices-Hermitian Matrices-Unitary matrices-Diagonalisation of matrices (Book 1 Chapter 2)Curvilinear coordinates: Orthogonal coordinates-Gradience, Divergence and curl in Orthogonal Curvilinear coordinates-Special coordinate systems--Cylindrical, spherical polar & Cartesian
(Book 1 Chapter 3).
Tensor and differential form: Tensor analysis-Introduction-definition-definition of different rank tensors-Contraction and direct product-quotient rule-pseudo tensors-General tensors-Metric tensors
(Book 1, Chapter 4)

Module II

Eigenvalue problems: Eigenvalue equations-matrix Eigenvalue problems-Hermitian eigenvalue problems-Hermitian matrix diagonalization-Normal matrices-(Book 1,Chapter 6)Ordinary differential equations: Introduction-First order equations-Second order linear ODEs-Series solution, Frobenius method-Inhomogeneous linear ODE's-Nonlinear differential equations
(Book 1, Chapter 7)

Module III

Complex variable theory: complex variable and functions-Cauchy Reimann conditions-Cauchy's integral theorem-Cauchy's integral formula—Laurent expansion-Singularities-Calculus of residues-Evaluation of definite integral-Evaluation of sums
(Book 1, Chapter 11)

Module IV

Orthogonal Polynomials:((Book 1, Chapter 12)Gamma function: definition properties-the Beta function (Book 1, Chapter 13)Bessel function: Bessel function of the first kind-orthogonality-Neumann's function,Bessel function of the second kind-Modified Bessel functions-spherical Bessel functions (Book 1, Chapter 14)Legendre functions: Legendre polynomial-orthogonality-physical interpretation of Generatingfunction-Associated Legendre equation-Spherical harmonics (Book 1,Chapter 15)More special functions: Hermite functions-Application of Hermite function-Laguerre functions
(Book 1,Chapter 18)

Book for study:

1. Arfken & Weber, Mathematical methods for Physicists by (Seventh edition), Academicpress.

Books for reference:

1. K.F.Riley Et al.Mathematical Methods for Physics and Engineering Cambridge University Press.
2. Pipes & Harvil, Applied Mathematics for Physicist & Engineers, McGrawHill

PHYCN1C02 CLASSICAL MECHANICS

(Contact hours -72 hrs; Max. Ext. Marks: 60; Max.Int.Marks:15)

Module 1

Scattering: Scattering in a central force field. Transformation of the scattering problem to laboratory coordinates.

Module 2

Lagrangian Formulation: Elementary Ideas of calculus of variation, Euler –Lagrangian equation –- Hamilton's principle-Deduction of Hamilton's principle-Principle of Least action. Lagrange's equation from Hamilton'sprinciple-Hamiltonian function.

Module 3

Hamiltonian Formulation: Configuration space and phase space-Hamilton's canonical equation-applications of Hamilton's equation-Two dimensional isotropic harmonic oscillator-Particle in a central force field-Charged particle in an electromagnetic field-Kepler problem.

Module 4

Canonical Transformation: Legendre Transformations-Canonical transformations-example-Infinitesimal canonical transformation-Poisson brackets-properties-Hamilton equations in Poisson bracket form-angular momentum Poisson brackets.

Module 5

Hamilton-Jacobi Formulation: Hamilton-Jacobi equations-Hamilton's principle and characteristic functions-Hamilton-Jacobi equation for linear Harmonic oscillator-Action angle variable-Hamilton-Jacobi formulation of Kepler problem-Hamilton-Jacobi equation and Schrodinger equation.

Module 6

Rigid Body Dynamics: Coordinate systems with relative translational motions-Rotating coordinate systems -Space fixed and body fixed systems of coordinates-Description of rigid body motion in terms of direction cosines and Euler angles-Infinitesimal rotations-Rate of change of a vector-Centrifugal and Coriolis forces-moment of Inertia Tensor-Euler's equation of motion -force free motion of a symmetric top (Book2)

Module 7

Small Oscillations: Formulation of the problem-Lagrange's Equations of motion for small oscillations-Eigenvalue equation-Frequency of free vibrations-Normal coordinates-Normal frequencies-Free vibrations of a linear triatomic molecule.

Books for study
1. Classical Mechanics, Herbert Goldstein
2. Classical Mechanics, Gupta Kumar & Sharma, Pragatti Prakashan
References
1. Introduction to Classical Mechanics, R G Takwale and P S Puranik, TMH
2. Classical Mechanics,J.C. Upadhyaya,
3. Classical Mechanics,G.Aruldhas, PHI. Classical Mechanics, A K Saxena,CBS

PHYCN1C03 ELECTRODYNAMICS

(Contact hours -72 hrs; Max. Ext. Marks: 60; Max.Int.Marks:15, Credit 4)

Module 1

Basic Concepts of Electrodynamics: Gauss law –Poisson’s equation and Laplace’s equation-method of images-Laplace equation in Cartesian, spherical and cylindrical coordinates -Biot-savart Law-Ampere’s theorem-Boundary value problems with linear dielectrics (Sphere and semi-infinite slab) (Units 2, 3, 4, 8 of T1 & Units 1, 3,4, 5 & 6 of T2)

Module 2

Maxwell's Equations and Propagation of Electromagnetic waves:Maxwell's equations and their empirical basis-The wave equation –Flow of electromagnetic energy (Poynting vector)-Boundaryconditions–PlaneElectromagnetic waves in a non-conducting media –Polarization –Plane monochromatic waves in a conducting media. (units 16, 17 of T1 & units 7, 8,9 of T2)

Module 3

Electromagnetic waves in bounded regions:Reflection and refraction of electromagnetic waves at the boundary of two non-conducting media for oblique incidence –Brewster angle, Critical angle -Propagation between parallel conducting plates –Waveguides and cavity resonators (Unit 18 of T1 & Unit 9 of T2)

Module 4

Potentials and fields:Scalar and vector potential – Gauge Transformations–The wave equation with sources - Retarded Potential – Liénard – Wiechert Potentials (Unit 10 of T2 &Units 16 and 21 of T1)

Module 5

Radiation: What is radiation? – Electric dipole radiation –Magnetic dipole radiation –Radiation by a point charge and power radiated-Larmor formula -Radiation damping-Radiation reaction: The Abraham-Lorentz formula. (Units 10, 11 of T2)

Module 6

Relativistic electrodynamics:Basic concepts of Lorentz Transformation –Geometry of space time – Lorentz transformation as an orthogonal transformation –Covariant form of electromagnetic equations like continuity equation, Maxwell's equations etc –The electromagnetic field tensor – Transformation law for the electromagnetic field. (Unit 22 of T1 & Unit 12 of T2)

Books for study

1.Foundations of electromagnetic Theory –John R.Reitz, Frederic J Milford, Robert W Christy, Third Edition, Narosa Publishing House.

2. Introduction to Electrodynamics, Third edition, David J Griffiths, Prentice Hall India

References

1. Classical electrodynamics-Third edition -John David Jackson (for module-1)

2. Introduction to electrodynamics: A Z Capri and P V Panat3. Field and Electromagnetics: David K Cheng

PHYCN1C04 ELECTRONICS

(Contact hours -72 hrs;Max. Ext. Marks: 60; Max.Int.Marks:15 Credits 4)

Module 1

OPERATIONAL AMPLIFIER:OperationalAmplifier---Differential amplifier circuit using transistors--Op -Amp basics--Op Amp specifications--DC offset parameters--Frequency parameters (Book 1) The ideal Operational amplifier—Open loop and closed loop Op-amp configurations –PSpice Simulation(qualitative idea only) Voltage series feedback amplifier—voltage shunt feedback amplifier --virtual ground--Practical Inverting Op-amp—Ideal Non inverting Op-amp—The voltage follower—Practical non inverting Op-amp—Op-amp parameters—General description of various stages used in Op-amp—type 741—Open loop and closed loop frequency response—frequency compensation—Dominant pole and pole zero compensations——slew rate—slew rate equation –effect of slew rate in applications (Book 2)Basic Op-amp circuits—Summing, scaling and averaging amplifiers—Voltage to current converter—Current to voltage converter—Integrator—Differentiator.
(Book 2)

Module2

Active filters: First order low-pass Butterworth filter—First order high-pass Butterworth filter—Square wave generator—triangular wave generator—sawtooth wave generator--(Book 2 Ch.7) Zero crossing detector—Schmitt Trigger—Comparators—Sample and hold circuit –voltage limiters (Book2 Ch.8)

Module3

Digital Electronics Multiplexers: Demultiplexers—Applications of Multiplexers (Book 3 Ch.7.22 to 7.24)Flip-flops and timing circuits: NOR gate and NAND gate SR latch—Gated latches—Edge triggered Flip Flops—Asynchronous inputs—Flip Flop operating characteristics—Maser Slave Flip flops—Conversion of flip Flops—Application of Flip Flops—Schmitt trigger—Monostable Multivibrator—Astable Multivibrator—Crystal controlled clock generators (Book 3 Ch. 8) Shift registers: Buffer Register—serial in serial out, serial in parallel out, parallel in serial out, parallel IN parallel out shift registers (Book3 Ch.9)
Counters: Asynchronous Counter—mod-8 ripple counter—synchronous counter (Book 3 ch.10)Digital to Analog and analog to digital converters:R-2R ladder type DAC—counter method ADC—Successive approximation type ADC (Book3 ch13)Memories: RAM, ROM, PROM, EPROM, EEPROM
(Book3 ch.14)

Module 4

Microprocessors: Intel 8085—functional block diagram—Register array—Developments of microprocessors from 8085 to core i7
(Book 4)

Books for study

1.Electronic devices and circuit theory—RobertL. Boylestad Louis Nashelsky (PHI)
2.Op-amps and Linear Integrated circuits—Ramakanth A. Gayakwad(PHI)
3.Fundamentalsof digital circuits—A. Anandkumar(PHI)
4.MicroprocessorArchitecture, Programming and applications with the 8085—Ramesh Goanka22

Books for reference:
1.A Text book of Electronics-S.L.Kakani., K.C. Bhandari (New age)
2.Electronics-analog and Digital-I.J.Nagrath (PHI)

PHYCN1P01 PRACTICAL I

(No credits for the semester.)
(At least 14 Experiments should be done) (At least two experiments from each cluster)

Cluster 1
1. Meyer’s oscillating disc – Viscosity of Liquid
2. Koenig’s method - Determination of Y and σ.
3. Vibrating strip – Mode constants

Cluster 2
1. Cornu’s Hyperbolic fringes – Determination of Y, σ and K with Pyrex.
2. Cornu’s elliptical fringes – Determination of Y, σ and K with glass.

3. Cauchy's constants - Determination of Cauchy's constants -λ sodium light
4. Rydberg constant – by spectrometer and diffraction grating

Cluster 3
1. Stefan's constant – Determination of Stefan's constant.
2. Thermocouple – Constants, Neutral and inversion temperatures (Calibrated potentiometer must be used)
3. Lee's Disc – K of liquid/powder and air using thermocouple & B.G

Cluster 4
1. Quincke's method – Susceptibility of a liquid at different concentrations.
2. Guoy's method – Susceptibility of glass and aluminium or suitable powder
3. Hysteresis – BH curve using CRO or B.G

Cluster 5
1. LASER –fundamental experiments-diameter of thin wire, Determination of wavelength using a diffraction grating,
2. LASER –Intensity distribution and divergence of the beam, Pitch of a screw.
3. LASER –Determination of refractive index of mirror substrate.

Cluster 6
1. Maxwell's L.C.Bridge –Determination of resistance and inductance of a given coil.
2. Transformer-efficiency, secondary impedance and inductance3. Anderson's bridge-Self-inductance

Reference Books

1. Dunlap.R.A. Experimental physics –modern methods,Oxford Universitypress (1988)
2. Malacara.D –Methods of Experimental Physics, Academic press
3. Smith E.V Manual of Experiments in Applied Physics –Butterworth.
4. Worsnop Flint, Advanced Practical Physics for students, Methuen & Co.
5. Practical Physics –S.L.Gupta & Kumar –Pragati Prakashan
6. C.J Babu, Lab manual, Calicut University
7. R S Sirohi-A course of experiments with He-Ne Laser-New Age International.

PHYCN1P02 PRACTICAL II

(No credits for I semester)
Electronics (At least 14should be done)
(At least two experiments should be done from each cluster)

Cluster 1

1. Series Voltage regulator with feedback using transistors (Regulation characteristic with load for different input voltages)
2. Series Voltage regulator with feedback using IC741. (Regulation characteristic with load for different input voltages)
3. Low voltage and high voltage regulators using IC723

Cluster 2

1. Two stage R.C Coupled transistor/FET amplifier (I/O resistance with and with outfeed back)
2. Negative feedback amplifier (I/O resistance with and with outfeed back)
3. Differential amplifier using transistors (Frequency response, CMRR)

Cluster 3

1. Wien Bridge oscillator using OP AMP (with simple resistive feedback and usingFET a voltage controlled resistor for amplitude stabilization)
2. Sawtooth Generator using transistors (for different frequencies)
3. Miller Sweep Circuits using OP AMPS. (For different frequencies)

Cluster 4

1. Measurements of OP AMP parameters
2. Schmitt TriggerusingOPAMP. (Trace Hysteresis curve, Determine LTP and UTP)
3. OP AMP –analogue integration and differentiation.

Cluster 5

1. Precision Full wave rectifier using OP AMP
2. Astable and monostablemultivibrator using OPAMP.
3. Voltage controlled oscillator using 555 IC
4. r.m.s. value of sine and triangular wave

Cluster 6

1. Binary Adders –HA and FA using NAND gates
2. D/A converter –a) Binary Weighted resistors b) R-2R Ladder (Four bit or more. Verify output for different digital inputs)
3. Study of Flip –Flops. RS & JK using IC 7400 (Verify Truth tables)

Computer Programming

(Problem analysis –algorithm –programming in C++ and execution)
(At least 6 should be done)

1. Familiarization of programming –Quadratic equations –solutions –real & complex Matrices -sum, product, Transpose & Trace.
2. Inverse of a Matrix
3. Programme to accept a decimal number as input and print the octal, Hexadecimal, binary and one’s complement of the binary as output.

4. Integration of a given function using the Simpson's 1/3 rule.
5. Lagrange Interpolation.
6. Solution of a set of linear equations by Gauss's elimination method.
7. To demonstrate Total internal reflection graphically for various values of refractive indices of the media.
8. Simulate motion of the planet around the sun and verify Kepler's laws. Use Newton – Feynman method.
9. Fourier analysis of a given periodic function.
10. Draw the i–d curve for various refractive indexes and study variation with the refractive index.
11. Variation of the field along the axis of a circular coil. Graphical representation for different values of currents and radii of the coils.
12. Simulate Brownian motion and random walk in two dimensions – Apply it for the study of noise.
13. Simulate damped harmonic motion and find a) Damping Coefficient b) Relaxation time c) Q –factor.

Reference Books:

1. Paul B Zbar and Malvine A.P –Basic Electronics –a lab manual TMH.
2. Begart R and Brown J –Experiments for electronic devices and circuits –Merrill International series.
3. Buchla –Digital Experiments –Merrill International series.
4. Jain R.P and Anand M.M.S Digital Electronics Practice using ICS, TMH.
5. Subramanian S.V –Experiments in Electronics –Mac Millan
6. S. Poorna Chandra Rao B.Sasikala –Hand book of Experiments in Electronics and Communication Engineering.
7. Electronic circuits-Fundamentals & applications-Mike Tooley(Routledge)
8. Electronics lab Manual-K.A.Navas
9. Numerical methods –E.Balagurusamy.
10. Numerical techniques –Gupta & Malik
11. Let's C++ Yashwant Kanetkar
12. Graphics under C++ Yashwant Kanetkar
13. Object Oriented Programming with C++ – E. Balaguruswamy

PHYCN1C05 EXPERIMENTAL TECHNIQUES

(No credit in semester I)

Module 1

Measurements of Fundamental Constants (e, h and c) – Measurement of High and Low Resistance, Inductance and Capacitance – Phase sensitive detection-Lock-in amplifiers Emission and Absorption Spectroscopy – Detection of X Rays, Gamma Rays, Charged Particles – Neutrons – Ionization Chamber – Proportional Counter – GM Counter – Scintillation Detector – Solid State Detectors – Measurements of Energy and Time Using Electronic Signals from the Detectors and Associated Instrumentation – Signal Processing – A/D Conversation and Multichannel Analyzers.

Module 2

Concept of Vacuum – Properties of Gases at Low Pressures – Gas Pressure – Velocity Distribution of Gas Molecules – Mean Free Path – Interaction of Gas Molecules with Surfaces – Adsorption Time – Saturation Pressure – Gas Flow – Conductance – Flow Calculations – Equation for Viscous Flow – Equation for Molecular Flow – Knudsen's Formulation.

Vacuum Pump Function – Basics – Gas Transport – Through put – Performance Parameter – Pumping Speed – Pump Down Time – Out gassing– Low Vacuum, High Vacuum and Ultra High Vacuum – Rotary pumps, Diffusion Pumps, Turbo molecular pump, Ion pump and Cryogenic Pump – Measurement of Flow Pressure – Direct Reading Gauges and Indirect Reading Gauges.

Textbooks:

1. Guthrie A, Vacuum Technology, John Wiley, 1963.

2. Rao V. V., Ghosh T. B., Chopra K.L., Vacuum Science and Technology.

3. Varier K. M., Pradyumnan P. P. and Antony Joseph, Advanced Experimental Techniques in Modern Physics, Pragati Edition, 2006.

4. Vacuum Technology By A. Roth third updated and enlarged edition, North Holland.

5. Lock-in amplifier- principles and applications by M. L. Meade

References:

1. S. Dushman and J. M. Laffer, Scientific Foundations of Vacuum Techniques.

2. L. C. Jackson, Low Temperature Physics, John Wiley & Sons Inc., 1962.

3. Dennis Heppel, Vacuum System Design.

SEMESTER II

PHYCN2C06 QUANTUM MECHANICS I (4C)

(Contact hours -72 hrs; Max. Ext. Marks: 60; Max.Int.Marks:15)

Module 1:
Mathematical tools of Quantum Mechanics: Hilbert space and wave functions -Dirac notation –Operators -Representation in discrete bases -Representation in continuous bases, (Book2 - Chapter 2 Section 2.1 to 2.6)

Module 2:
The formulation of Quantum Mechanics: Fundamental postulates –The equation of motion –Schrodinger, Heisenberg and Interaction pictures –Uncertainty principle –Wave packet and its time development –Linear harmonic oscillator in Schrodinger and Heisenberg picture. (Book1-Relevant sections of Chapter 3 and 4)

Module 3:
Theory of Angular Momentum and Hydrogen atom: Orbital angular momentum –General formalism of angular momentum –Matrix representation of angular momentum –Spin angular momentum –Eigen functions of orbital angular momentum –3D problems in spherical coordinates –The Hydrogen atom –Addition of angular momentum –Clebsch Gordan coefficients. (Book2 chapter 5.1 to5.4, 5.6, 5.7, 6.3.1, 6.3.5and 7.3)

Module 4:
Symmetry and Conservation Laws: Space-time symmetries, Space translation and conservation of linear momentum-Time translation and conservation of energy-Space rotation and conservation of angular momentum, Space inversion and time reversal.(Book1-Chapter 6)

Module 5:
Approximation methods for stationary states: Time independent perturbation theory -non degenerate and degenerate cases -stark and effect in Hydrogen atom -Variational method for bound states -Ground state energy of He atom-WKB approximation (Book2-Section 9.1 to9.2.2 and 9.3, 9. 4.1 –9.4.3)

Books for study
1.V.K. Thankappan : "Quantum Mechanics" (Wiley Eastern Ltd)
2.N. Zettili, "Quantum Mechanics –Concepts and applications iII Edition (John Wiley & Sons, 2004)
References:
1. L.I.Schiff : "Quantum Mechanics" (McGraw Hill)
2. P.M.Mathews and K.Venkatesan : "A Textbook of Quantum Mechanics" (Tata McGraw Hill)
3. A.Messiah : "Quantum Mechanics"
4. J.J.Sakurai :"Modern Quantum Mechanics" (Addison Wesley)
5. Stephen Gasiorowics : "Quantum Physics"
6. A.Ghatak and S.Lokanathan : "Quantum Mechanics" (Macmillan)
7. Eugence Merzbacher, Quantum Mechanics

PHYCN2C07 MATHEMATICAL PHYSICS II (4C)

(Contact hours -72 hrs;Credit-4;Max. Ex. Marks: 60; Max.Int.Marks:15)

Module 1

Infinite Series(Book 1, Chapter 1) Infinite series-Series of function-Binomial theorem

Modules 2:

Partial differential equations(Book 1, Chapters 9):Introduction-First order equations-Second order equations-Separation of variables-Laplace and Poisson's equations-Wave equation-Heat flow, or Diffusion PDE.Green's function (Book 1, Chapter 10)One dimensional problems -Problems in two and three dimensions.

Module 3

Integral transforms(Book 1, Chapter 20):Introduction-Fourier transform-Properties of Fourier transform-Fourier convolution theorem-Signal processing applications-Discrete Fourier transform-Laplace transform-Properties of Laplace transform-Laplace convolution theorem-Inverse Laplace transform.

Module 4:

Group theory(Book 2 Chapters 1 and 3)Definition of groups-Abelian and Non Abelian group-multiplication table-rearrangement theorem-conjugate element and classes-sub groups-direct product groups-Isomerism and homomorphism –permutation groups-representation of groups-invariant subspaces and reducible representations-irreducible representations -Schur's lemmas -orthogonality theorem-proof and interpretation-characters of representation-character table-irreducible representation of C3V and C4V - qualitative idea of continuous groups, O(3),SU(2) and SU(3) groups.

Books for study:
1. ARFKEN & WEBER, Mathematical methods for Physics (Seventh edition),Academic press.
2. A.W.Joshi Group theory for Physicists,Wiley.
Books for reference:
1. K.F.Riley et al.,Mathematical methods for Physics and Engineering Cambridge University Press.
2. Pipes And Harvill, Applied Mathematics for Physicist & Engineers, McGraw Hill.

PHYCN2C08 STATISTICAL MECHANICS (4C)

(Contact hours -72 hrs; Credit-4; Max. Ex. Marks: 60; Max.Int.Marks:15)

Module 1:

Overview of classical Thermodynamics Postulates of equilibrium thermodynamics, Intensive parameters of thermodynamics, The Euler and Gibbs-Duhem relations, Thermodynamic Potentials, Max wells relations (Chapter-3 ofT2)

Module 2:

Statistical Basis of Thermodynamics and Micro canonical Ensemble The macroscopic and microscopic states. Contact between statistics and thermodynamics (Boltzmann relation between entropy and microstates) -Further contact between statistics and thermodynamics-Classical ideal gas. Gibbs paradox. The correct enumeration of microstates (Distinguishability and Indistinguishability). Phase space. Liouville's theorem and its significance The microcanonical ensemble—Examples (Classical ideal gas and Simple harmonic oscillator) Quantum states and phase space. (Chapters 1&2 of T1)

Module 3:

The Canonical Ensemble and Grand canonical ensemble: Canonical ensemble-Equilibrium Between system and reservoir. A system in the canonical ensemble -method of most probable values- Physical significance of statistical quantities in the canonical ensemble. Partition function for non-generate and degenerate systems. Thermodynamics of classical systems like free particles (ideal gas). Thermodynamics of harmonic oscillators and quantum harmonic oscillators.Energy fluctuations in the canonical ensemble. Equipartition theorem and virial theorem. Grand canonical ensemble-Equilibrium between a system and a particle-energy reservoir.A system in Grand canonical ensemble. Physical Significance of statistical quantities. Classical ideal gas, one dimensional classical and quantum oscillators as examples in a grand canonical ensemble. Energy and density fluctuations in the grand canonical ensemble. (Chapters 3&4 of T1)

Module 4:

Theory of simple gases An ideal gas in quantum mechanical micro canonical ensemble-An ideal gas in other quantum mechanical ensembles-statistics of occupation numbers (Chapter-6 of T1)

Module 5:

Ideal Bose and Fermi Systems Validity criterion of the classical limit. Thermodynamic behavior of an ideal Bose gas. Bose-Einstein condensation.Bose-Einstein condensation in ultracold atomic gases (BEC in harmonic oscillator potential).Planck's theory of radiation.Behavior of an ideal Fermi gas.Fermi temperature and Fermi energy. Magnetic behaviour of ideal Fermi gas –Pauli paramagnetism-Landau diamagnetism. (Chapters 7 & 8 of T1)

Module 6:

Phase transitions and Critical Phenomena Simple fluids-simple uniaxial ferromagnets. The Landau phenomenology-Dynamical model of phase transitions-Ising model definition-The lattice gas and the binary alloy-The Ising model in one dimension (Chapter 12 of T2 and Chapters 12 &13 of T1)

Books for study

1 R K.Pathria and Paul D Beale, Statistical Mechanics, Butterworth Heinemann, III Edn. T
2 Silvio R A Salinas Introduction to Statistical physics I Edn Springer International Edition

References

1. Landau &Lifeshitz, Statistical Physics, Pergman.M
2. F. Reif, Fundamentals of Statistical and Thermal Physics, McGraw Hill
3. Roger Bowley and Mariana Sanchez, Introductory Statistical Mechanics, Oxford Science Publications -South Asian Edition
4 . Introduction to Statistical Mechanics-John Dirk Walecka, World Scientific, First Edition B K Agarwal & Melvin Eisner-Statistical Mechanics II Edn.

PHYCN2C09 SPECTROSCOPY (4C)

(Contact hours -72 hrs;Credit-4;Max. Ex. Marks: 60; Max.Int.Marks:15)

Module-1:

Atomic spectroscopy: Introduction to atomic spectroscopy-the Hydrogen atom and the three quantum numbers-spectra of alkali metals-elements with more than one outer valence electron-forbidden transitions and selection rules-vector atom model-normal Zeeman effect-anomalousZeeman effect-magnetic moment of the atom and g factor-emitted frequencies in anomalousZeeman transitions-Paschen-Back effect-Stark effect.

Module-2:

Microwave spectroscopy: Regions of the spectrum-classification of molecules, interaction of radiation with rotating molecules-rotational spectra of rigid diatomic molecules-the intensity of spectral lines-the effect of isotopic substitution-the non-rigid rotator-linear polyatomic molecules-symmetric top molecules-asymmetric top molecules. Microwave spectrometer.

Module-3:

Infrared spectroscopy: The vibrating diatomic molecule-the energy of a diatomic molecule-the simple harmonic oscillator-the anharmonic oscillator-the diatomic vibrating rotator-breakdown of Born-Oppenheimer approximation-the interactions of rotations and vibrations-the vibration of polyatomic molecules-fundamental vibrations and their symmetry-the influence of the rotation on the spectra of polyatomic molecules-linear molecules-symmetric top molecules-other polyatomic molecules.

Module-4:

Raman spectroscopy: Quantum theory of Raman effect-pure rotational Raman spectra-linear molecules-symmetric top molecules-spherical top molecules-asymmetric top molecules—vibrationalRaman spectra—rotational fine structure-structure determination from Raman and Infrared spectroscopy. Raman spectrometer.

Module-5:

Electronic spectroscopy of moleculesElectronic spectra of diatomic molecules-the Born-Oppenheimer approximation-vibrational coarse structure: progressions-intensity of vibrational electronic spectra-Frank-Condon principle-rotational fine structure of electronic vibrational transitions-the Fortrat diagram.

Module-6:

Spin Resonance spectroscopySpin and an applied field-the nature of spinning particles-interaction between nuclear spin and magnetic field-the Larmour precession-NMR spectroscopy-Hydrogen nuclei-chemical shift-ESR spectroscopy-the position of ESR absorptions-the g factor

Module-7:

Mossbauer spectroscopy Principles of Mossbauer spectroscopy-applications-chemical shift-Quadrupole effects-effect of magnetic field.

Books

1.G. Aruldas: Molecular structure and spectroscopy -prentice hall
2.Collin N Banwell and McCash : Fundamentals of molecular spectroscopy 4thEdn-TMH
3.B P Straughn & S Walker: Spectroscopy volume1-Chapman and Hall
4.HE White Introduction to atomic Spectra

PHYCN2P01 PRACTICAL I (3C)

(At least 14 Experiments should be done) (At least two experiments from each cluster)

Cluster 1

1. Meyer’s oscillating disc –Viscosity of Liquid
2. Koenig’s method -Determination of Y and σ.
3. Vibrating strip – Mode constants

Cluster 2

4. Cornu’s Hyperbolic fringes –Determination of Y, σ and K with Pyrex.
5. Cornu’s elliptical fringes –Determination of Y, σ and K with glass.
6. Cauchy’s constants -Determination of Cauchy’s constants -λ sodium light
7. Rydberg constant –by spectrometer and diffraction grating

Cluster 3

8. Stefan’s constant –Determination of Stefan’s constant.

9. Thermocouple –Constants, Neutral and inversion temperatures (Calibrated potentiometer must be used)
10. Lee's Disc –K of liquid/powder and air using thermocouple & B.G

Cluster 4

11. Quincke's method –Susceptibility of a liquid at different concentrations.
12. Guoy's method –Susceptibility of glass and aluminium or suitable powder
13. Hysteresis –BH curve using CRO or B.G

Cluster 5

14. LASER –fundamental experiments-diameter of thin wire, Determination of wavelength using a diffraction grating,
15. LASER –Intensity distribution and divergence of the beam, Pitch of a screw.
16. LASER –Determination of refractive index of mirror substrate.

Cluster 6

17. Maxwell's L.C.Bridge –Determination of resistance and inductance of a given coil.
18. Transformer-efficiency, secondary impedance and inductance
19. Anderson's bridge-Self-inductance

Reference Books

1. Dunlap.R.A. Experimental physics –modern methods,Oxford Universitypress (1988)
2. Malacara.D –Methods of Experimental Physics, Academic press
3. Smith E.V Manual of Experiments in Applied Physics –Butterworth.
4. Worsnop Flint, Advanced Practical Physics for students, Methuen & Co.
5. Practical Physics –S.L.Gupta & Kumar –Pragati Prakashan
6. C.J Babu, Lab manual, Calicut University
7. R S Sirohi-A course of experiments with He-Ne Laser-New Age International.

PHYCN2P02 PRACTICAL II (3C)

Electronics (At least 14 should be done)
(At least two experiments should be done from each cluster)

Cluster 1

1. Series Voltage regulator with feedback using transistors (Regulation characteristic with load for different input voltages)
2. Series Voltage regulator with feedback using IC741. (Regulation characteristic with load for different input voltages)
3. Low voltage and high voltage regulators using IC723

Cluster 2

4. Two stage R.C Coupled transistor/FET amplifier (I/O resistance with and without feed back)
5. Negative feedback amplifier (I/O resistance with and with outfeed back)
6. Differential amplifier using transistors (Frequency response, CMRR)

Cluster 3

7. Wien Bridge oscillator using OP AMP (with simple resistive feedback and usingFET a voltage controlled resistor for amplitude stabilization)
8. Sawtooth Generator using transistors (for different frequencies)

9. Miller Sweep Circuits using OP AMPS. (For different frequencies)

Cluster 4

10. Measurements of OP AMP parameters
11. Schmitt Trigger using OPAMP. (Trace Hysteresis curve, Determine LTP and UTP)
12. OP AMP –analogue integration and differentiation.

Cluster 5

13. Precision Full wave rectifier using OP AMP
14. Astable and monostable multivibrator using OPAMP.
15. Voltage controlled oscillator using 555 IC
16. r.m.s. value of sine and triangular wave

Cluster 6

17. Binary Adders –HA and FA using NAND gates
18. D/A converter –a) Binary Weighted resistors b) R-2R Ladder (Four bit or more. Verify output for different digital inputs)
19. Study of Flip –Flops. RS & JK using IC 7400 (Verify Truth tables)

Computer Programming

(Problem analysis –algorithm –programming in C++ and execution)
(At least 6 should be done)

1. Familiarization of programming –Quadratic equations –solutions –real & complex Matrices -sum, product, Transpose & Trace.
2. Inverse of a Matrix
3. Programme to accept a decimal number as input and print the octal, Hexadecimal, binary and one's complement of the binary as output.
4. Integration of a given function using the Simpson's 1/3 rule.
5. Lagrange Interpolation.
6. Solution of a set of linear equations by Gauss's elimination method.
7. To demonstrate Total internal reflection graphically for various values of refractive indices of the media.
8. Simulate motion of the planet around the sun and verify Kepler's laws. Use Newton – Feynman method.
9. Fourier analysis of a given periodic function.
10. Draw the i–d curve for various refractive indexes and study variation with the refractive index.
11. Variation of the field along the axis of a circular coil. Graphical representation for different values of currents and radii of the coils.
12. Simulate Brownian motion and random walk in two dimensions – Apply it for the study of noise.
13. Simulate damped harmonic motion and find a) Damping Coefficient b) Relaxation time c) Q –factor.

Reference Books:

1. Paul B Zbar and Malvine A.P –Basic Electronics –a lab manual TMH.
2. Begart R and Brown J –Experiments for electronic devices and circuits –Merrill International series.
3. Buchla –Digital Experiments –Merrill International series.

4. Jain R.P and Anand M.M.S Digital Electronics Practice using ICS, TMH.
5. Subramanian S.V –Experiments in Electronics –Mac Millan
6. S. Poorna Chandra Rao B.Sasikala –Hand book of Experiments in Electronics and Communication Engineering.
7. Electronic circuits-Fundamentals & applications-Mike Tooley(Routledge)
8. Electronics lab Manual-K.A.Navas
9. Numerical methods –E.Balagurusamy.
10. Numerical techniques –Gupta & Malik
11. Let's C++ Yashwant Kanetkar
12. Graphics under C++ Yashwant Kanetkar
13. Object Oriented Programming with C++ –E. Balaguruswamy

PHYCN2C05 EXPERIMENTAL TECHNIQUES (2C)

Module 1

Measurements of Fundamental Constants (e, h and c) – Measurement of High and Low Resistance, Inductance and Capacitance – Phase sensitive detection-Lock-in amplifiers Emission and Absorption Spectroscopy – Detection of X Rays, Gamma Rays, Charged Particles – Neutrons – Ionization Chamber – Proportional Counter – GM Counter – Scintillation Detector – Solid State Detectors – Measurements of Energy and Time Using Electronic Signals from the Detectors and Associated Instrumentation – Signal Processing – A/D Conversation and Multichannel Analyzers.

Module 2

Concept of Vacuum – Properties of Gases at Low Pressures – Gas Pressure – Velocity Distribution of Gas Molecules – Mean Free Path – Interaction of Gas Molecules with Surfaces – Adsorption Time – Saturation Pressure – Gas Flow – Conductance – Flow Calculations – Equation for Viscous Flow – Equation for Molecular Flow – Knudsen's Formulation.

Vacuum Pump Function – Basics – Gas Transport – Through put – Performance Parameter – Pumping Speed – Pump Down Time – Out gassing– Low Vacuum, High Vacuum and Ultra High Vacuum – Rotary pumps, Diffusion Pumps, Turbo molecular pump, Ion pump and Cryogenic Pump – Measurement of Flow Pressure – Direct Reading Gauges and Indirect Reading Gauges.

Textbooks:

1.Guthrie A, Vacuum Technology, John Wiley, 1963.
2. Rao V. V., Ghosh T. B., Chopra K.L., Vacuum Science and Technology.
3.Varier K. M., Pradyumnan P. P. and Antony Joseph, Advanced Experimental Techniques in Modern Physics, Pragati Edition, 2006.
4.Vacuum Technology By A. Roth third updated and enlarged edition, North Holland.

References:

1.S. Dushman and J. M. Laffer, Scientific Foundations of Vacuum Techniques.
2. L. C. Jackson, Low Temperature Physics, John Wiley & Sons Inc., 1962.
3. Dennis Heppel, Vacuum System Design.

SEMESTER III

PHYCN3C10 QUANTUM MECHANICS II (4C)

(Contact hours -72 hrs; Credit-4; Max. Ex. Marks: 60; Max.Int.Marks:15)

Module 1:

Time dependent perturbation theory:Time dependent perturbation theory - Transition probability, Transition probability for a constant Perturbation – Transition probability for a Harmonic perturbation, Interaction of an atom with radiation - Induced emission and absorption, The dipole approximation – selection rules.(Book2-chapter 10 relevant sections)

Module 2:

Theory of scattering: Scattering cross section, scattering amplitude of spinless particles – scattering amplitude and differential cross section- The Born approximation - Method of partial waves for elastic scattering, phase shifts, Optical theorem, , The Born approximation, (Book2 chapter11 – relevant sections)

Module 3:

Identical particles: Identical particles, Construction of symmetric and antisymmetric wave functions- Slater determinant, Pauli exclusion principle - Bosons and Fermions, Spin and Statistics - Two electron systems- Helium atom – Scattering of identical particles. (Book1-Chapter9)

Module 4:

Relativistic Quantum Mechanics:Early developments, the Klein-Gordon equation, charge and current densities, The Dirac equation, Dirac matrices, solution of free particle Dirac equation, spin of the electron, Equation of continuity, Hole theory, Dirac equation with potentials, Non-relativistic limit, Dirac equation for Hydrogen atom, Spin orbit coupling, Covariance of Dirac equation, The Weyl equation for the neutrino, Nonconservation of parity, Wave equation for photon, Charge conjugation for the Dirac and Klein Gordon equation, CPT theorem.
(Book1 chapter 10 relevant sections)

Module 5:

Quantization of fields:The principles of canonical quantization of fields, Lagrangian density and Hamiltonian density, Second quantization of the Schrödinger wave field for bosons and fermions,(Book1Chapter 11relevant sections)

Module 6:

Interpretations of Quantum Mechanics: Quantum theory of measurement, Delayed choice experiment, Einstein-Bohr controversy, EPR paradox, Hidden variables, Bell's theorem, Epistemological and Ontological problems raised by quantum Mechanics
(Book1 Chapter 12)

Books for study

1. V.K. Thankappan: "Quantum Mechanics" (Wiley Eastern)
2 .N.Zettili, , “Quantum Mechanics – Concepts and applications’ (John Wiley & Sons,2004)

References:

1. L.L. Schiff : Quantum Mechanics" (McGraw Hill)
2. J.J. Sakurai : "Advanced Quantum Mechanics " (Addison Wesley)
3. Stephen Gasiorowicz : "Quantum Physics"Wiley
4.Powell and Crascmann, Quantum Mechanics, Addison-Wesley.
5. Biswas S.N. Quantum Mechanics
6. Bransden and Joachain, Introduction to quantum Mechanics, ELBS
7 . P.M Mathews and Venkatesan., “A Textbook of Quantum Mechanics" (Tata McGraw Hill)
8. J.D. Bjorken and D. Drell : “Relativistic Quantum Fields” (McGraw Hill 1998)

PHYCN3C11 SOLID STATE PHYSICS (4C)

(Contact hours -72 hrs; Credit-4; Max. Ex. Marks: 60; Max.Int.Marks:15)

Module 1:
Bragg law - Scattered wave amplitude - Brillouin Zones - Fourier analysis of the basis - Quasicrystals
(Chapter 2)

Module 2:
Vibrations of crystals with monatomic and diatomic basis - Quantization of elastic waves - phonon momentum - Phonon heat capacity
(Chapters 4 & 5)

Module 3 :
Energy levels in 1D - Effect of temperature on Fermi - Dirac distribution - Free electron gas in three dimension - Heat capacity of electron gas - Electrical conductivity and Ohm’s law - Hall effect -Thermal conductivity of metals – Nanostructures - Nearly free-electron model - Bloch functions - Kronic-Penny model - Wave equation of electron in a periodic potential
(Chapters 6 & 7)

Module 4:
Band gap - equations of motion - Intrinsic carrier concentration - Impurity conductivity - Calculation of energy bands
(Chapters 8 & 9)

Module 5:
Superconductivity - Experimental and Theoretical survey
(Chapter 12)

Module 6:
Ferroelectric crystals –Antiferroelectricity - Ferroelectric domains – Piezoelectricity - Langevin equation - Quantum theory of diamagnetism of mononuclear systems - Quantum theory of paramagnetism - Cooling by isentropic demagnetization - ferromagnetic, ferrimagnetic and antiferromagnetic order - ferromagnetic domains - single domain particles
(Chapters 14 & 15)

Text Books
1. C.Kittel-Introduction to Solid State Physics-VII Edition –John Wiley & Sons.
References
1. A.J.Dekker –Solid State Physics – Macmillan
2. Azaroff.V –Introduction to Solids-TMH
3. Omar Ali-Elementary Solid State Physics-Addison Wesley.
4. J.S.Blakemore-Solid State Physics-Cambridge University Press.
5. S.O.Pillai-solid State Physics-New Age International Publishers.
6. Gupta-Solid State Physics – Vikas Publishing
7. V.S Muraleedharan & A Subramania – Nano Science & Technology- Ane Books Pvt Ltd,2009
8. Bharat Bhushan(Ed), Handbook of NanoTechnology, Springer 2003
9. Gouzhong Cao, Nano structure and Nano materials: Synthesis, Properties and applications, Imperial college press, 2004
10. M.A.Wahab –Solid State Physics-Structure and Properties of Materials-Narosa Pub.

PHYCN3C12 NUCLEAR AND PARTICLE PHYSICS (4C)
(Contact hours -72 hrs; Credit-4; Max. Ex. Marks: 60; Max.Int.Marks:15)

Module-1:

1. Basic properties of nucleii and study of nuclear force: Nuclear size, shape, mass and binding energy, semi empirical mass formula, Angular momentum and parity, nuclear electromagnetic moments, characteristics of nuclear force, the deuteron, nucleon-nucleon scattering the exchange force model.
Texts: Introductory Nuclear Physics by Kenneth S Krane
Sections: - 3.1 $\rightarrow$ 3.5, 4.1, 4.2, 4.4& 4.5
Reference Books: (1) Introduction to Nuclear Physics by Harald Enge
(2) Nuclear Physics by Roy & Nigam

Module-2:

2. Nuclear Models: The shell model, shell model potential, spin-orbit potential, magnetic dipole moments, electric quadruple moments, valence nucleons, Even Z-even N nucleii and collective structure.
Text: Kenneth S Krane- Section 5.1 & 5.2
Reference: Harald Enge and Roy & Nigam

Module-3:

3. Nuclear Decays: Beta decay, Energy release in beta decay, Fermi theory of beta decay, Experimental tests of the Fermi theory, angular momentum and parity selection rules, parity violation in beta decay. Energetics of gamma decay, classical electromagnetic radiation, transition to quantum mechanics, angular momentum and parity selection rules, Internal conversion.
Text: Kenneth S Krane - Sections 9.1 $\rightarrow$9.4 and 9.9, 10.1 $\rightarrow$10.4 and 10.6
Ref : Harald Enge and Roy & Nigam

Module-4:

4. Nuclear Reactions, Fission and Fusion:Types of reactions and conservation laws, Energetics of nuclear reactions, reaction cross sections,compound nucleus reactions, Nuclear fission, characteristics of fission, energy in fission, Nuclear fusion: basic fusion processes, characteristics of fusion, solar fusion.
Text: Kenneth S Krane - sections 11.1, 11.2, 11.4 and 11.10, 13.1, 13.2 and 13.3, 14.1, 14.2 and 14.3
References : Harald Enge and Roy & Nigam

Module-5:

5. Particle Physics: Basic forces and classification of particles: The four basic forces, The force of gravity, the electromagnetic force, the week force and electroweak theory, the strong force. Conservations laws: Conservation laws and symmetries, conservation of energy and mass, conservation of linear momentum, conservation of angular momentum, conservation of electric charge,conservation of baryon and lepton numbers, conservation of strangeness, conservation of isospin and its components, the TCP theorem, conservation of parity. Quark model: The eightfold way, discovery of omega minus, the quark model, the confined quarks, experimental evidences for quark model, coloured quarks, quantum chromodynamics and gluons, Enough exercises.

Text: The particle Hunters - Yuval Ne‟eman & Yoram kirsh
Sections : 6.1-6.3, 7.1-7.11 and 9.1-9.8.

References: 1. Introductory nuclear Physics by Samuel S.M. Wong, Chapter 2
2. Introduction to Elementary Particles-David Griffiths.

PHYCN3C13 PHYSICS AT NANOSCALE (3C)

Module 1

Introduction to nanoscale systems of different dimensions (0-D, 1-D, and 2-D) and their realizations. Electronic properties of quantum confined systems like quantum wells, quantum wires, and quantum dots. (Book 1 Ch 6.1-6.2)

Module 2

Electric transport in a wire – ballistic regime, quantization of conductance, Landauer formula, current in terms of chemical potential, Fermi function, Field effect transistor –Coulomb blockade, current-voltage characteristics, negative differential resistance. (Book1 Ch 6.3-6.4, Ch 9.4)

Module 3

Transport in the magnetic field- Low B, High B, SDH oscillations. Landau quantization, QHE, edge states Quantum interference effects, Electronic phase coherence, Aharonov-Bohm effect, weak localization. (Book2 Ch3 ch4, ch5)

Module 4
Optical properties of nanoscale systems. Nanomagnetism: Superparamagnetism of nano-particles, spintronics, spin-valve effect, spin- FET.

Book:
1. Quantum Transport: Atom to Transistor, Supriyo Datta (Cambridge University Press, 2005),
2. Electronic Transport in Mesoscopic Systems: (Cambridge Studies in Semiconductor Physics and Microelectronic Engineering) by Supriyo Datta
3. Solid State Physics, Neil Ashcroft, N. Mermin, Brooks/Cole.
4. Spintronics in Nanoscale Devices, Eric R. Hedin, Yong S. Joe, Pan Stanford Publishing,CRC Press, 2013

Reference:
1. Lessons From Nanoelectronics: A New Perspective On Transport - Part A: Basic Concepts: 5 (Lessons from Nanoscience: A Lecture Notes Series) by Supriyo Datta
2. Lessons From Nanoelectronics: A New Perspective On Transport - Part B: Quantum Transport: 5 (Lessons from Nanoscience: A Lecture Notes Series) by Supriyo Datta

PHYCN3C14 COMPUTATIONAL PHYSICS (3C)

Module 1

Software Basics and Errors/Uncertainties: Error analysis, Propagation of errors. Roots of functions, Bracketing and open-end methods: Bisection Method, False position method and Newton Raphson method. Construction of orthogonal Legendre, Laguerre, and Hermite polynomials using recurrence relations.

Scientific libraries and scientific plotting packages: LAPACK, Gnu Scientific Library (GSL), Data visualization- Python Plotting/ Gnu plot.

Machine Learning - search algorithms, Artificial Neural Networks.
Embedded Computing: Arduino, Low-Level computing: FPGA

Module 2

Monte Carlo Techniques: Introduction to random numbers, Monte Carlo method for random number generation, Chi-square test.
Numerical Differentiation and Integration: Differentiation of continuous functions Integration by Trapezoidal and Simpson's rule, Gaussian quadrature, multi-dimensional integrals. Monte-Carlo integrations.
Matrix Computation: Spectral decomposition of complex matrices (Finding eigenvalues and eigenvectors), Energy and wave function of quantum systems, Ex. Particle in a box, Basis transformation of complex matrices.

Module 3

Searching and Fitting: Linear Interpolation, Lagrange and Newton Interpolation, Cubic spline interpolation, Linear and non-linear curve fitting.
Differential Equations: Euler method and Runge-Kutta method, Phase space trajectory of a non-linear oscillator (Example: van der Pol oscillator, Duffing oscillator, etc.), motion of a charged particle in an electric field.ODE Applications
Module 4
High-Performance Computing, Parallel computation: Fourier series, Fourier Transforms and Discrete Fourier transform
Nonlinear Dynamics- Flows in one, two, and three dimensions, Strange attractor, One dimensional discrete maps (Logistic maps), bifurcation, chaos, lyapunov exponent. Introduction to molecular dynamics - first principle solution, potential determination Basics of Density Functional Theory (DFT).

Text Books:

1. Computational Physics, Problem Solving with Computers, Rubin H. Landau, Manuel J. Paez and Cristian C. Bordeianu, John Wiley, and Sons, Inc.
2. Michael T. Heath: Scientific computing. An introductory survey, from McGraw-Hill.
3. Learning Scientific Programming with Python by Christian Hill published in 2015 by Cambridge University Press.
4. Tao Pang, an Introduction to Computational Physics (Cambridge University Press) 2nd edition, 2006.
5. J. P. Boyd, Chebyshev and Fourier Spectral Methods, Dover, 2001.
6. S. E. Koonin, Computational Physics, Westview, 1990.
7. P. L. Devries, J. E. Hasbun, A First Course in Computational Physics, Jones & Bartlett, 2011.
8. H. Gould, J. Tobochnik, W. Christian, An Introduction to Computer Simulation Methods: Applications to Physical Systems, Pearson, Addison-Wesley, 2007.
9. Steven H. Strogatz, Nonlinear dynamics and chaos with student solutions manual: With applications to physics, biology, chemistry, and engineering, CRC press, 2018.

Reference Books:

1. The Nature of Mathematical Modelling, N. Gershenfeld, Cambridge University Press.
2. Press et. al, Numerical Recipes.
3. Effective Computation in Physics, Kathryn Huff and Anthony Scopatz, O'Reilly Media, Inc.
4. Computational Physics, N.J. Giordano, 1997, Prentice-Hall.
5. Physics by Computer, W. Kinzel & G. Reents, 1998, Springer-Verlag.
6. Introducing Python: Modern Computing in Simple Packages, B. Lubanovic, 2015, O'Reilly Media, Inc.
7. Python for Data Analysis, Wes McKinney, 2013, O'Reilly Media, Inc.
8. Python and Matplotlib Essentials for scientists and engineers, Matt A. Wood, 2015, Morgan & Claypool Publishers.
9. Practical IDL Programming, L.E. Gumley, 2002, Morgan-Kaufmann.

PHYCN3P03 PRACTICAL III – NANOSCIENCE LAB (3 Credits)

(At least 14 experiments should be done)

1. Measurement of resistance of a thin film using Lock-in amplifier-extraction of small signal from high noise.
2. I-V Characteristics of 1D materials
3. I-V characteristics of thin film-distinguish between metallic material and insulating material
4. Hall Effect measurement on thin film.
5. Planar Hall effect (PHE) measurements on magnetic nanofilms
6. Interfacing stepper motor with PC using Arduino and standard controllers
7. Interfacing measurement equipment with PC using python/
8. Controlling the temperature of a heating element using temperature sensor and Arduino/python (PWM or DC via PID control)
9. Solar cell – Spectral response and I-V characteristics
10. Measuring the absorption spectrum of nanoparticles/films using UV-VIS spectrometer.
11. Determination of energy Bandgap of semiconductor by UV spectroscopy
12. Determination of the particle size of the given materials using He-Ne LASER.
13. Verification of Lambert Beer's law and determination of concentration of unknown solution by UV-Vis spectrophotometer.
14. Synthesis of any nanoparticle by Chemical (Chemical reduction/Sol-gel/coprecipitation) method and their characterization by UV-VIS/FTIR
15. Fabrication of semiconductor thin film coatings using spin coating technique and characterisation
16. To determine the Band-Gap of given Semiconductor using Four Probe Method from Liquid Nitrogen Temp to Room Temperature
17. XRD data analysis : Determination of crystallite size and lattice constant
18. TEM Data analysis-Image J.
19. XPS Data analysis.
20. SEM Data analysis-Surface roughness.
21. Growing thin film via PVD (Thermal evaporation/sputtering/e-beam evaporation) inside a High Vacuum chamber.
22. Hall Effect in semiconductors – To determine the carrier concentration in the given specimen of semiconductor material.
23. Determination of band gap energy in silicon.
24. Determination of band gap energy in germanium.
25. Thin films – To determine the electrical conductivity, reflectivity, sheet resistance and refractive index.
26. Four probe method – To study the bulk resistance and the band gap energy of the given semiconductor.
27. LED characteristics – Determination of wavelength of emission, current-voltage characteristics and variation with temperature, variation of output power with applied voltage etc.
28. Photoelectric effect – Determination of Planck's constant (White light and filters or LEDs of different colours may be used).

29. Growth of a single crystal from the solution and determination of their structural, electrical and optical properties.
30. Expansion of crystal – By optical interference method.
31. Photoelectric effect – Electronic charge and work function of metal
32. Photoelectric cell – Study of elliptically polarized light using deadbeat galvanometer, quarter wave plate, and nicol prism.

References:

1. B.D. Cullity, Elements of X-ray diffraction, Addison Wesley Publishing company, Massachusetts, USA., 1978.
2. C.Suryanarayana, M.G. Norton, X-ray Diffraction A Practical Approach, Plenum Press,
   New york, 1998.
3. M. De Graef, Introduction to Conventional Transmission Electron Microscopy, Cambridge university Press, United kingdom, 2003.
4. C.R. Brundle, C.A.E. Jr., S. Wilson, Encyclopedia of materials characterization, Reed Publishing, USA, 1992.
5. Worsnop Flint – Advanced Practical Physics – Methuen & Co.
6. C.J Babu, Lab manual, Calicut University

PHYCN3P04 PRACTICAL IV – COMPUTATIONAL PHYSICS LAB (3 Credits)

(At least 14 experiments should be done. Python may be used for programming)

1. Write a program for studying the variation of magnetic field along the axis of a coil.
2. Design and simulate electromagnet using Finite Element Method Magnetics
3. Write a program to generate random numbers using a mid square method and to simulate random walk using these random numbers.
4. Write a program for generating square wave, triangular wave and sawtooth wave using the Fourier technique.
5. Write a program to interpolate the value of a function using Lagrange's interpolating polynomials.
6. Write a program to perform matrix addition, subtraction and multiplication and to find the trace and transpose of a matrix.
7. Write a program to plot the Maxwell-Boltzmann distribution and to prove the equipartition theorem.
8. Write a program to plot Bose-Einstein distribution and to prove the Stefan-Boltzmann law and Wein's displacement law.
9. Write a program to plot Fermi-Dirac distribution.
10. Write a program to study the trajectory of an ion in the Cyclotron Accelerator.
11. Write a program to study the barrier penetration (wave function outside and inside a barrier).

12. Write a program to plot the trajectory of a particle undergoing random motion in one and two dimensions.
13. The solution of Transcendental Equation by Bisection Method and Newton's Method.
14. System of nonlinear equations: Bisection Method and Newton-Raphson's Method.
15. Numerical Solution to PDE - Stability And Convergence.
16. To study the numerical convergence and error analysis of non-linear equations using Newton Raphson method.
17. To find the value of y for the given value of x using Newton's interpolation method.
18. Perform numerical integration on 1-D function using Trapezoid rule and Simpson rules.
19. Study the motion of the spherical body falling in the viscous medium using the Euler method.
20. To study the path of the projectile with and without air drag using Feynman-Newton method.
21. To obtain the energy eigenvalues of a quantum oscillator using the Runge-Kutta method.
22. Study the motion of charged particles in a uniform electric field, uniform magnetic field and combined uniform EM field.
23. Study of the EM oscillation in an LCR circuit using the Runge-Kutta method.
24. Find out equilibrium bond length and ground state energy of Hydrogen molecules using First Principle methods.
25. Determination of value of pi using the metropolis algorithm.
26. Monte Carlo simulation of the 2D Ising model.
27. Using Tight binding model, determine the band structure of graphene numerically
28. Compute and analyze the electronic structure of semiconductors such as Si and Ge.
29. Compute and analyze the electronic structure of metals such as Au and Pt.
30. Electronic structure of graphene using density functional calculations.
31. Electronic structure of the 1D lattice.
32. Write a program to generate Orthogonal Hermite and Laguerre Polynomials using recursion relations. Plot the first few polynomials as a function of the argument.
33. Write a program to generate Orthogonal Legendre polynomials using recursion relations. Plot the first few polynomials as a function of the argument.
34. Starting with the matrix representation of creation and annihilation operators, write a program to construct the Hamiltonian of a quantum duffing oscillator. Find the first few energy levels and plot the corresponding position wave functions.
35. Write a program to implement the change of basis for a complex matrix.

36. Write a program to plot the phase space trajectory of a limit cycle oscillator (van der Pol oscillator, Stuart-Landau oscillator, etc.)
37. Write a program to study the period doubling in a logistic map.
38. Write a program to plot the strange attractor for Lorenz system- use rk4 routine to solve the system of equations.
39. Write a program to study the time evolution of a gaussian wave packet in infinite square well potential.
40. Write a program to study the phase space trajectory of a damped harmonic oscillator.

References:

1. Computational Physics, Problem Solving with Computers, Rubin H. Landau, Manuel J. P´aez and Cristian C. Bordeianu, John Wiley, and Sons, Inc.
2. Michael T. Heath: Scientific computing. An introductory survey, from McGraw-Hill.
3. Learning Scientific Programming with Python by Christian Hill published in 2015 by Cambridge University Press.
4. Tao Pang, an Introduction to Computational Physics (Cambridge University Press) 2nd edition, 2006.
5. J. P. Boyd, Chebyshev and Fourier Spectral Methods, Dover, 2001.
6. S. E. Koonin, Computational Physics, Westview, 1990.
7. P. L. Devries, J. E. Hasbun, A First Course in Computational Physics, Jones & Bartlett, 2011.
8. H. Gould, J. Tobochnik, W. Christian, An Introduction to Computer Simulation Methods: Applications to Physical Systems, Pearson, Addison-Wesley, 2007.
9. Steven H. Strogatz, Nonlinear dynamics and chaos with student solutions manual: With applications to physics, biology, chemistry, and engineering, CRC press, 2018.
10. The Nature of Mathematical Modelling, N. Gershenfeld, Cambridge University Press.
11. Press et. al, Numerical Recipes.
12. Effective Computation in Physics, Kathryn Huff and Anthony Scopatz, O’Reilly Media, Inc.
13. Computational Physics, N.J. Giordano, 1997, Prentice-Hall.
14. Physics by Computer, W. Kinzel & G. Reents, 1998, Springer-Verlag.
15. Introducing Python: Modern Computing in Simple Packages, B. Lubanovic, 2015, O’Reilly Media, Inc.
16. Python for Data Analysis, Wes McKinney, 2013, O’Reilly Media, Inc.
17. Python and Matplotlib Essentials for scientists and engineers, Matt A. Wood, 2015, Morgan & Claypool Publishers.

SEMESTER IV

PHYCN4C15 OPTICS (4C)

Module- 1: Laser and Modern Optics
Quantum Optics: Spatial and temporal coherence, classical coherence correlation function; Basic idea of quantum coherence correlation function, coherent states and its properties Laser: Interaction of radiation with matter, Einstein coefficients, Light amplification; Population Inversion, pumping processes; rate equation for three and four level systems; Semi-classical theory of lasers, Cavity modes, Quality factor of cavity and ultimate linewidth of laser. Directionality and monochromaticity of laser and coherence properties. Principles of Ruby, He-Ne, CO2 ,Dye and Semiconductor Lasers.

Module -2
Electro-optic effect - Kerr effect, Pockels effect, Electro-optic amplitude and phase modulation, Electro-optic effect in KDP crystals-longitudinal and transverse modes, electrooptic effect in Lithium Niobate, index ellipsoid in the presence of an external electric field, Magneto-optic effect - Faraday effect optical activity. Nonlinear interactions of light and matter Nonlinear polarization of the medium, Optical susceptibility tensor, Generation of second harmonic, Sum frequency and difference frequency generation, Optical rectification, Parametric amplifier and oscillation, Generation of third harmonic, Intensity dependent refractive index, Self-focusing, Wave equation for nonlinear optical media, Coupled wave equation for sum frequency generation,. Generation of second harmonic – Phase matching – Type I and Type II phase matching – Frequency mixing – Parametric amplifiers and oscillator –Spatial solitons – Stimulated Raman scattering (SRS) – Inverse Raman scattering (IRS) – Stimulated Raman Gain Spectroscopy (SRGS) – Coherent Antistokes Raman Scattering (CARS)

Module– 3 : Fibre Optics
Single mode and multimode with different refractive index profiles. Ray theory transmission-total internal reflection, acceptance angle, numerical aperture, transmission characteristics of optical fibres: attenuation and dispersion.,Signal Degradation In Fibers - Attenuation, Absorption, Scattering and Bending losses in fibers, Core and Cladding losses. Signal distortion in optical waveguides: Material dispersion, waveguide dispersion and intermodal dispersion. Pulse broadening in optical fibers. Power launching in Optical fibers, Source-output pattern,optical fibre amplifier as next generation lasers

References:
1. Lasers and Non-Linear Optics by B.B.laud (Wiley East. Ltd., New Delhi)
2. Quantum Optics by S.H.Kay and A.Maitland (Academic Press, London)
3. Nonlinear Optics by P.G.Harper and B.S.Wherrett (Academic Press, London)
4. . Laser spectroscopy: Edited by J.L.Hall

ELECTIVE COURSES (3C):

1. PHYCN4E01 CRYSTAL GROWTH, THIN FILMS and CHARACTERISATION

Module I: CRYSTAL GROWTH

Basic concepts and experimental methods of crystal growth: nucleation phenomena, mechanisms of growth, dislocations and crystal growth, crystal dissolution, phase equilibria, phase diagrams and material preparation, growth from solid –solid equilibria, liquid-solid equilibria, vapour-solid equilibria, mono-component and multi-component techniques. Crystal characterization.

Module II: THIN FILM GROWTH

Methods of Preparation/Synthesis of Thin Films: Vacuum Evaporation: Resistive Heating, MBE, Electron Beam Evaporation and Pulsed Laser Deposition – Sputtering: Glow Discharge, Radio Frequency and Magnetron Sputtering – Chemical Methods: MOCVD, ALD, LCVD, PCVD and PECVD – Spin coating-Spray Method: Spray Hydrolysis and Spray Pyrolysis – Langmuir Blochet Technique – Sol-gel Deposition.

Module III SYNTHESIS OF NANOMATERIALS

Introduction to nanomaterials, General methods of synthesis, Chemical methods for the synthesis of Nanomaterials, Sol-gel method, Co-precipitation method, Chemical reduction method, Hydrothermal method, Micro-emulsion method, Reverse micelle method, Solvo thermal method, Sono chemical method and solid-state method.

Module IV: CHARACTERISATION

Thickness Measurements: Resistance, Capacitance, Microbalance, Quartz Crystal Thickness Monitor, Optical Absorption-reflection-transmission, Multiple Beam Interference, Interference Colour and Ellipsometry Methods. Scanning electron microscopy, Atomic force microscopy, XRD, and Focused ion beam machining, TEM, LEED, MEED, RHEED, XPS. Hall effect.

Book:

1. Laudise, R. A. ; Growth of Crystals, Prentice-Hall, 1970
2. Hurle, D. T. J.,(ed.), Hand Book of Crystal Growth, Ed., North Holland 1994
3. Chopra , K. L., Thin Film Phenomena, McGrow Hill, USA, 1969
4. In Situ Real-Time Characterization of Thin Films, Orlando Auciello and Alan R Krauss, Published under licence by IOP Publishing Ltd
5. B.D. Cullity, Elements of X-ray diffraction, Addison Wesley Publishing company, Massachusetts, USA., 1978.
6. C.R. Brundle, C.A.E. Jr., S. Wilson, Encyclopedia of materials characterization, Reed Publishing, USA, 1992.
7. The Chemistry of Nanomaterials :Synthesis , Properties and Applications., A.Muller, A.K.Cheetham (Eds.),(2004) WILEY-VCH Verlag GmbH&Co.,Weinheim.
8. .Janos H .Fendler (Editor) Nanoparticles and Nanostructured Films Preparation,

Characterization and Applications , Wiley –VCH (1998)
9. G.Cao, Nanostructures and Nanomaterials: Synthesis, properties and applications, Imperial
College Press, 2004.

2. PHYCN4E02 NANO OPTICS

Module I

Introduction; Examples of nano-optical systems and potential applications; A review of electrodynamics for nano-optics.

Module II

Propagation and focusing of fields; Spatial resolution, principles of near-field microscopy; Nanoscale optical microscopy; Nano-optical probes.

Module III

A brief introduction to Surface Plasmons; Plasmonic phenomena and nano-antennas – their practical usage in photonic devices.

Module IV

Photonic semiconductors - energy bands diagram and their unique properties Quantum structure and the tailoring capabilities for photonics devices in nanoscales dimensions. Quantum wells, quantum wires and quantum dots infrared photodetectors. LED, OLED and quantum wells lasers - quantum confinement; Advance solid state lasers – quantum cascade lasers - Graphene and Carbon Nano-Tubes (CNT) and their roles in photonics devices.

Textbook

1. Principles of Nano-optics, Lukas Novotny and Bert Hecht, Cambridge University Press, 2006.

Reference Books:

1. Nano-Optics, Fundamentals, Experimental Methods, and Applications, Sabu Thomas et. al (Eds.), Elsevier, 2020.
2. Nano-optics, Satoshi Kawata, Motoichi Ohtsu, and Masahiro Irie, Springer, 2002.
3. Surface Plasmons on Smooth and Rough Surfaces and on Gratings, Heinz Raether, Springer-Verlag, 1988.
4. Nanophotonics with Surface Plasmons, Vlademir Shalaev and Satoshi Kawata, Elsevier, 2007.
5. Tip Enhancement, Satoshi Kawata and Vlademir Shalaev, Elsevier, 2007.
6. Near-Field Optics and Surface Plasmon Polaritons, Satoshi Kawata, Motoichi Ohtsu, and Masahiro Irie, Springer-Verlag, 2001.

3. PHYCN4E03 Advanced Computational Physics

Module I: Grid Methods for Classical and Quantum Fields

Mathematical models for fluid dynamics: classification of partial differential equations, discretization methods, finite difference formulation, numerical solution of elliptic equations linear system of algebraic equations, numerical solution of parabolic equations, stability analysis, numerical solution of hyperbolic equations, finite element method, finite volume method, Burgers equation, time integration schemes, incompressible Navier-Stokes equations and their solution algorithms. Quantum Wave Equations, Numerical Solution of Compressible Flows[Book 1]

Module II: Data Analysis and Learning

Time series, correlations and probability distributions, TISEAN package for nonlinear time series analysis, Lyapunov exponent calculation using time series. (Multi)-fractal analysis of turbulent time-series
Machine Learning - Search algorithms, ANN. The Social Rules of Finite Difference Methods
Predicting X-events, The Hopfield Neural Network.[Book 1]

Module III: Complex States of Matter

Lattice Boltzmann for Fluids; Lattice Boltzmann for Soft Matter; Agent-based Models for Active Matter.[Book 1]

Module IV: Computational condensed matter physics
Many body Schrodinger Equations; Born Oppenheimer approximation; Hartree Approximation; Slater determinants; Hartree Fock method; Hohenberg-Kohn theorem; Kohn Sham equations.[Book 2]

Book for study

1. Hirsch, C., Numerical Computation of Internal and External Flows: The Fundamentals of Computational Fluid Dynamics, Vol. I, 2nd ed., Butterworth-Heinemann (2007).
2. Electronic structure: basic theory and practical methods: Richard Martin
3. Elementary electronic structure, W: A. Harrison

References

1. Tannehill, J. C., Anderson, D. A., and Pletcher, R. H., Computational Fluid Mechanics and Heat Transfer, 2nd ed., Taylor & Francis (1997).
2. Hoffmann, K. A. and Chiang, S. T., Computational Fluid Dynamics for Engineers, 4th ed., Engineering Education Systems (2000).
3. Anderson, J. D., Computational Fluid Dynamics: The Basics with Applications, McGrawHill (1995).
4. Patankar, S. V., Numerical Heat Transfer and Fluid Flow, Hemisphere (1980).
5. Ferziger, J. H. and Peric, M., Computational Methods for Fluid Dynamics, 3rd ed., Springer (2002).
6. R. Hegger, H. Kantz, and T. Schreiber, *Practical implementation of nonlinear time series methods: The TISEAN package*, CHAOS**9**, 413 (1999)
7. https://www.pks.mpg.de/~tisean/Tisean_3.0.1/index.html

PHYCN4C16 SCIENTIFIC DOCUMENTATION AND PRESENTATION (1C)

Module 1

Perform a comprehensive literature search, write a comprehensive literature survey and critical review of research papers. Ethics and Plagiarism- tools

Module 2

Write a convincing and appropriate experimental design for a chosen research problem.

Module 3

Perform critical analysis of experimental designs; explain the importance of controls and sample sizes in experimental design; Discuss issues of ethics approval of experiments.

Module 4

Write a convincing project proposal.

Reference Books

1. From Research to Manuscript: A Guide to Scientific Writing, Michael Jay Katz, Springer, 2006.
2. How to Write & Publish a Scientific Paper, Robert A. Day, The Oryx Press, 1998.
3. How to Write a Lot: A Practical Guide to Productive Academic Writing, Paul J. Silvia, APA LifeTools; Second edition (September 1, 2018).
4. How to Write a Scientific Paper: An Academic Self-Help Guide for PhD Students, Jari Saramäki, 2018.
5. How to Write and Publish a Scientific Paper: The Step by Step Guide, Luz Claudio.
6. Entering Research: A Curriculum to Support Undergraduate & Graduate Research Trainees, Janet L. Branchaw, Amanda R. Butz & Amber Smith. W. H. Freeman; Second edition (July 10, 2019).
7. Scientific Integrity and Research Ethics: An Approach from the Ethos of Science, David Koepsell, Springer; 2017.
8. Research Methods for Science, Michael P. Marder, Cambridge University Press, 2011.
9. LABORATORY LIFE: The Construction of Scientific Facts, Bruno Latour & Steve Woolgar, Princeton University Press, 1986.
10. Research Methodology - a step-by-step guide for beginners, Kumar, Ranjit, Sage Publishers.
11. Research Methodology: Methods & Techniques, C. R. Kothari, 2004.
12. The Researchers' Bible, Alan Bundy, Ben du Boulay, Jim Howe and Gordon Plotkin University of Edinburgh, 1995.

PHYCN4Pr01 PROJECT (7C)

The students must perform a satisfactory amount of work for the project, submit interim reports, the final report and prepare & display a poster (these will be evaluated separately with due credits).

This project aims to:

- Encourage the development of professional attitude and to take increasing responsibility for their own learning;
- Encourage independent thought and work;
- Develop technical skills and understanding in a chosen speciality;
- Provide an opportunity to work in an area at the leading edge of scientific research/technology;
- Develop communication and presentation skills, both for a written report and a poster presentation;

Intended Learning Outcomes of Course: By the end of this course students will be able to:

- Work independently, exhibiting a high level of ethical and professional conduct;
- Demonstrate the methodologies associated with their chosen project area;
- Communicate effectively at all levels in the industrial or academic environment;
- Formulate and follow a long-term project plan in a clear, methodical manner;
- Research the scientific and engineering literature relevant to a specific area of engineering;
- Demonstrate intelligent application of their prior knowledge, skills and understanding within a field that may be unfamiliar to them;
- Conduct high quality technical work as an individual in a commercial or academic environment;
- Write a substantial technical report in clear English;
- Prepare a poster summarising a project activity.