SACRED HEART COLLEGE (AUTONOMOUS), THEVARA,

KOCHI, KERALA, 682013

CURRICULUM AND SYLLABUS

CREDIT AND SEMESTER SYSTEM (CSS-PG)

POST-GRADUATE PROGRAMME IN

PHYSICS

(INTRODUCED FROM 2020 ADMISSION ONWARDS)

BOARD OF STUDIES IN PHYSICS
Sacred Heart College, Thevara, Kochi, Kerala

PostgraduateProgramme Outcomes (POs)

At the end of the programme the students are able to,

PO1

Exercise their critical thinking in creating new knowledge leading to innovation, entrepreneurship and employability.

PO2

Effectively communicate the knowledge of their study and research in their respective disciplines to their stakeholders and to the society at large.

PO3

Make choices based on the values upheld by the institution, and have the readiness and know-how to preserve the environment and work towards sustainable growth and development.

PO4

Develop an ethical view of life and have a broader (global) perspective transcending the provincial outlook.

PO5

Explore new knowledge independently for the development of the nation and the world and are able to engage in a lifelong learning process.

Programme Specific Outcomes (PSOs)

At the end of the programme a student should be able to:

PSO1

Develop the skills of critical analysis and problem-solving required in the application of principles of Physics.

PSO2

Acquire a working knowledge of experimental and computational techniques and instrumentation required to work independently in research or industrial environments.

PSO3

Demonstrate a strong capability of organizing and presenting acquired knowledge both in oral and written platforms.

PSO4

Compete for current employment opportunities successfully.

CHAPTER 1 : GENERAL SCHEME OF SYLLABUS

CHAPTER 2: COURSE STRUCTURE AND SYLLABUS

CHAPTER 1 : GENERAL SCHEME OF SYLLABUS

PG PROGRAMME REGULATIONS FOR SEMESTER SYSTEM 2020

1. SCOPE

1.1. These regulations provided here in shall apply to all post-graduate programmes, conducted by Sacred Heart College (S.H. College), Thevara with effect from the academic year 2020-2021 admission onwards.

2. DEFINITIONS

2.1. '**Academic Committee'** means the Committee constituted by the principal under this regulation to monitor the running of the Post-Graduate programmes under the Choice Based Credit System (CBCS-PG).

2.2. 'Programme' means the entire course of study and examinations.

2.3. '**Duration of Programme'** means the period of time required for the conduct of the programme. The duration of post-graduate programme shall be of 4 semesters.

2.4. **'Semester'** means a term consisting of a minimum of 90 working days, inclusive of examination, distributed over a minimum of 18 weeks of 5 working days, each with 5 contact hours of one hour duration

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

2.6. **'Credit' (Cr)** of a course is the numerical value assigned to a paper according to the relative importance of the content of the syllabus of the programme.

2.7. '**Programme Credit'** means the total credit of the PG Programmes, ie; **80 credits**.

2.8. '**Programme Core course'** Programme Core course means a course that the student admitted to a particular programme must successfully complete to receive the Degree and which cannot be substituted by any other course.

2.9. **'Programme Elective course'** Programme Elective course means a course, which can be chosen from a list of electives and a minimum number of courses is required to complete the programme.

2.10. '**Programme Project'** Programme Project means a regular project work with stated credits on which the student undergo a project under the supervision of a teacher in the parent department / any appropriate Institute in order to submit a dissertation on the project work as specified.

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

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

2.13. '**Seminar'** seminar means a lecture expected to train the student in self-study, collection of relevant matter from the books and Internet resources, editing, document writing, typing and presentation.

2.14. '**Evaluation'** means every course shall be evaluated by 25% internal assessment and 75% external assessment.

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

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

2.17. '**Department'** means any teaching Department offering a course of study approved by the college / Institute as per the Act or Statute of the University.

2.18. '**Parent Department'** means the Department which offers a particular Post graduate programme.

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

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

2.21. '**College Co-ordinator** means a teacher from the college nominated by the College Council to look into the matters relating to CBCS-PG System.

2.22. **'Letter Grade'** or simply '**Grade**' in a course is a letter symbol (S, A, B, C, D, etc.) which indicates the broad level of performance of a student in a course.

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

2.24. **'Credit point'** (CP) of a course is the value obtained by multiplying the grade point (GP) by the Credit (Cr) of the course CP=GP x Cr.

2.25. **'Extra credits'** are additional credits awarded to a student over and above the minimum credits required for a programme for achievements in co-curricular activities carried out outside the regular class hours as directed by the College /Departments.

2.26. '**Semester Grade point average'** (SGPA) is the value obtained by dividing the sum of credit

points (CP) obtained by a student in the various courses taken in a semester by the total number of credits taken by him/her in that semester . The grade points shall be rounded off to two decimal places. SGPA determines the overall performance of a student at the end of a semester.

2.27. **Cumulative Grade point average'** (CGPA) is the value obtained by dividing the sum of credit points in all the courses taken by the student for the entire programme by the total number of credits and shall be rounded off to two decimal places.

2.28. '**Grace Marks'** means marks awarded to course/s, as per the orders issued by the college from time to time, in recognition of meritorious achievements in

NCC/NSS/Sports/Arts and cultural activities.

2.29. 'Words **and expressions'** used and not defined in this regulation but defined in the Mahatma Gandhi University Act and Statutes shall have the meaning assigned to them in the Act and Statute.

3. ACADEMIC COMMITTEE

3.1. There shall be an Academic Committee constituted by the principal to manage and monitor the working of (CBCS-PG) 2020.

3.2. The Committee consists of

(a) The principal

(b) The vice principal

(c) Deans of the faculties of science, arts and commerce

(d) The Controller of Examinations

(e) The superintendent of the college

(f) IQAC co-ordinator

4. PROGRAMME STRUCTURE

4.1 Students shall be admitted into post graduate programmes under the various faculties.

4.2 The programme shall include two types of courses, Program Core (C) courses and Program Elective (E) Courses. There shall be a Program Project (D) with dissertation to be undertaken by all students. The Programme will also include assignments, seminars, practical (P), viva (V), Tour / study tour etc., if they are specified in the Curriculum

4.4 Project work

4.4.1 Project work shall be completed by working outside the regular teaching hours.

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

4.4.3 A candidate may, however, in certain cases be permitted to work on the project in an industrial / Research Organization/ Institute on the recommendation of the Supervisor.

4.4.4 There should be an internal assessment and external assessment for the project work in the ratio 1:3

4.4.5 The external evaluation of the Project work is followed by presentation of work including dissertation and Viva-Voce.

4.4.6 The mark and credit with grade awarded for the program project should be entered in the grade card issued by the college.

4.5 **Assignments**: Every student shall submit one assignment as an internal component for every course.

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

4.7 Every student shall undergo **two class tests** as an internal component for every course.

4.8 Comprehensive Viva-voce shall be conducted at the end semester of the programme which covers questions from all courses in the programme.

5. ATTENDANCE

5.1 The minimum requirement of aggregate attendance during a semester for appearing the end semester examination shall be 75%. Condonation of shortage of attendance to a maximum of 10 days in a semester subject to a maximum of two times during the whole period of Post Graduate programme may be granted by the University college, subject to the recommendation by class-teacher/HOD.

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

5.3 A student who does not satisfy the requirements of attendance shall not be permitted to take the end Semester examinations.

5.4 Those students who are not eligible even with condonation of shortage of attendance shall repeat the course along with the next batch

6. BOARD OF STUDIES AND COURSES.

6.1 The Board of Studies concerned shall design all the courses offered in the PG programme. The Boards shall design and introduce new courses, modify or re-design existing courses and replace any existing courses with new/modified courses to facilitate better exposures and training for the students.

6.2 The syllabus of a course shall include the title of the course, contact hours, the number of credits and reference materials.

6.3 Each course shall have an alpha numeric code, which includes abbreviation according to the following criteria. For example, the course code 20P1PHYT01 can be illustrated as shown below.

20	P	1	PHY	T/P/PT/CV	01
Year	PG	Semester 1	PHYSICS	Theory/ Practical/ Project/ Comprehensive viva	Paper number

6.4 Every Programme conducted under Choice Based Credit System shall be monitored by the academic committee and College Council.

7. REGISTRATION.

7.1 A student shall be permitted to register for the programme at the time of admission. The duration of the PG Programme shall be 4 semesters.

7.2 A student who registered for the course shall complete the course within a period of continuous semesters from the date of commencement of the programme.

8. ADMISSION

8.1 The admission to all PG programmes shall be as per the rules and regulations of the college.

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

8.3 There shall be provision for inter collegiate and inter University transfer within a period of two weeks from the date of commencement of the semester.

8.4 There shall be provision for credit transfer subject to the conditions specified by the Board of Studies concerned.

9. ADMISSION REQUIREMENTS

9.1 Candidates for admission to the first semester of the PG programme through CBCS shall be required to have passed an appropriate Degree Examination of Mahatma Gandhi

University as specified or any other examination of any recognized University or authority accepted by the Academic council of the college as equivalent thereto.

9.2 The candidate must forward the enrolment form to the Controller of Examinations of the college through the Dean / Head of the Department.

9.3 The candidate has to register all the courses prescribed for the particular semester. Cancellation of registration is applicable only when the request is made within two weeks from the time of admission.

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

10. PROMOTION: A student who registers for the end semester examination shall be promoted to the next semester

11. EXAMINATIONS

11.1 There shall be an external examination at the end of each semester.

11.2 The answers must be written in **English** except for those coming under Faculty of languages.

11.3 Practical examinations shall be conducted by the college at the end of even semesters as per the syllabus.

11.4 Project evaluation and Comprehensive Viva –Voce shall be conducted at the end of the programme only. Practical examination, Project evaluation and Comprehensive VivaVoce shall be conducted by two external examiners.(For professional courses, one

Examiner can be opted from the same college itself)

11.5 There shall be one end-semester examination of 3 hours duration in each lecture based course (Theory).

11.6 A question paper may contain multiple choice / objective type, short answer type, short essay type questions/problems and long essay type questions. Different types of questions shall have different marks, but a general pattern may be followed by the Board of Studies.

12 **EVALUATION AND GRADING**

12.1 Evaluation: The evaluation scheme for each course shall contain two parts; (a) internal evaluation (ISA) and (b) external evaluation (ESA). 25 marks shall be given to internal evaluation and 75 marks to external evaluation so that the ratio between internal and external mark is 1:3. Both internal and external evaluation shall be carried out in mark system. Both internal and external marks are to be mathematically rounded to the nearest integer.

12.2 Internal evaluation: The internal evaluation shall be based on predetermined transparent system involving periodic written tests, assignments, seminars / viva and attendance in respect of theory courses and based on written tests, lab skill/records/viva and attendance in respect of practical courses. The marks assigned to various components for internal evaluation is as follows.

12.3 Components of Internal Evaluation

All the components of the internal evaluation are mandatory

a) For Theory

	Components	**Marks**
i.	Assignment	5
ii	Field Visit/Seminar	5
iii	Viva	5
iv	Two Test papers(2x5)	10
	Total	**25**

b) For Practical

Components	**Marks**
Record*	5
Written/Lab test	5
Laboratory Involvement/ punctuality	10
Viva	5
Total	**25**

*Marks awarded for Record should be related to number of experiments recorded

c) For Project

Components	Marks
Topic/Area selected	2
Experimentation/Data collection	5
Punctuality	3
Compilation	5
Content	5
Presentation	5
Total	**25**

12.4 Evaluation of **Viva** (For Theory and Practicals)

Components	Mark
Subject Knowledge	2
Presentation Skill	1
Logical/scientific thinking	2
Total	**5**

Assignment

Components	Marks
Punctuality 1	
Content	2
Conclusion	1
Reference/Review	1
Total	**5**

Seminar

Components	**Marks**
Content	2
Presentation	2
Reference/Review	1
Total	**5**

Comprehensive Viva

Components	**Marks**
Advanced level questions	1
Masters level questions	2
Basic level questions	2

12.5 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 mark.

12.6 The course teacher and the faculty advisor shall maintain the academic record of each student registered for the course which shall be forwarded to the controller of examinations through the Principal and a copy should be kept in the college for at least two years for verification.

12.7 **External Evaluation:** The external examination in theory courses shall be conducted by the college with question papers set by external experts /question bank. The evaluation of the answer scripts shall be done by the examiners based on a well-defined scheme of evaluation given by the question paper setters. The external evaluation shall be done immediately after the examination preferably through the centralised valuation.

12.8 The question paper should be strictly on the basis of model question paper set by BoS with due weightage given for each module of the course and there shall be a combined meeting of the question paper setters and experts for scrutiny and finalisation of question paper. Each set of question should be accompanied by its scheme of valuation.

12.9 **For** all courses (theory & practical), Letter grades and grade point are given on a 10-point scale based on the total percentage of marks, (ISA+ESA) as given below:-

Percentage of Marks	**Grade**	**Grade Point (GP)**
95 and above	O Outstanding	10
85 to below 95	A+ Excellent	9
75 to below 85	A Very Good	8
65 to below 75	B+ Good	7
55 to below 65	B Above Average	6
45 to below 55	C Average	5
40 to below 45	D Pass	4
Below 40	F Fail	0
Absent	Ab	0

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

GPA	Grade
Equal to 9.5 and above	***O Outstanding***
Equal to 8.5 and below 9.5	***A+ Excellent***
Equal to 7.5 and below 8.5	***A Very Good***
Equal to 6.5 and below 7.5	***B + Good***
Equal to 5.5 and below 6.5	***B Above Average***
Equal to 4.5 and below 5.5	***C Average***
Equal to 4.0 and below 4.5	***D Pass***
Below 4.0	***F Failure***

12.10 A **separate minimum of 40% marks** (D grade) required for a pass for both internal evaluation and external evaluation for every course.

12.11 A candidate who has not secured minimum marks/credits in internal examinations can re-do the same registering along with the end semester examination for the same semester, subsequently.

12.12 A student who fails to secure a minimum marks/grade for a pass in a course will be permitted to write the ESA examination along with the next batch. **There will be no improvement examinations**

12.13. **Extra Credits**

Study visit to a research lab / industry	1
For undergoing a training with a minimum duration of 40 hours in nonconventional energy sources/energy management	2
Total extra credits	3

12.14. After the successful completion of a semester, Semester Grade Point Average (SGPA) of a

student in that semester is calculated using the formula given below. For the successful

completion of semester, a student should pass all courses and score a minimum SGPA of 4.0

However, a student is permitted to move to the next semester irrespective of her/his SGPA.

Credit Point (CP) of a course is calculated using the formula

CP = Cr x GP, where Cr = Credit; GP = Grade point

Semester Grade Point Average (SGPA) of a Semester is calculated using the formula

SGPA = TCP/TCr, where

TCP = Total Credit Point of that semester= $\sum^{n}{}_{1}$ CPi;
TCr = Total Credit of that semester = $\sum^{n}{}_{1}$ Cri
Where n is the number of courses in that semester
Cumulative Grade Point Average (CGPA) of a Programme is calculated using the formula $\sum(\boldsymbol{TCP} \times \boldsymbol{TCr})$ CGPA = $/\sum \boldsymbol{TCrGPA\ shall\ be\ round\ off\ to\ two\ decimal\ places}$

12.15 PATTERN OF QUESTIONS

Questions shall be set to assess knowledge acquired, standard, application of knowledge, critical evaluation of knowledge and the ability to synthesize knowledge. The question setter shall ensure that questions covering all skills are set. He/She shall also submit a detailed scheme of evaluation along with the question paper.

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

Pattern of questions for external examination for theory paper

Type of Questions	Total no. of questions	Number of questions to be answered	Marks of each question	Total marks
Section A – multiple choice	5	5	1	05
Section B- Short Answer	10	7	2	14
Section C - Short essay/ Problems	6	4	5	20
Section D - Long essay	6	3	12	36
Grand Total	**27**	**19**		**75**

Pattern of questions for external examination of practical papers will decided by Practical exam board chairman as per the guidelines of Board of Studies.

13. **GRADE CARD**

The colleges under its seal shall issue to the students, a grade card on completion of each semester, which shall contain the following information.

a) Name of the College
b) Title of the Postgraduate Programme
c) Name of the Semester
d) Name and Register Number of the student
e) Code, Title, Credits and Max. Marks (Internal, External & Total) of each course (theory& Practical) in the semester.
f) Internal, External and Total Marks awarded, Grade, Grade point and Credit point in each course in the semester
g) The total credits, total marks (Max. & Awarded) and total credit points in the semester
h) Semester Grade Point Average (SGPA) and corresponding Grade.
i) Cumulative Grade Point Average (CGPA)

j) The final Mark cum Grade Card issued at the end of the final semester shall contain the details of all courses(theory & practical) taken during the final semester examination and shall include the final grade/marks scored by the candidate from 1st to 3rd semester, and the overall grade/marks for the total programme.

14. **AWARD OF DEGREE**

The successful completion of all the courses with 'D' grade (40%) shall be the minimum requirement for the award of the degree

15. **MONITORING COMMITTEE**

There shall be a Monitoring Committee constituted by the principal consisting of faculty advisors, HODs, Teaching-Learning-Evaluation committee member and college coordinator to monitor the internal evaluations conducted by college. The Course teacher, Faculty Advisor, and the College Coordinator should keep all the records of the internal evaluation, for at least a period of two years, for verification.

16. **GRIEVENCE REDRESSAL MECHANISM**

In order to address the grievance of students regarding Continuous internal assessment (CIA) a three-level Grievance Redressal mechanism is envisaged. A student can approach the upper level only if grievance is not addressed at the lower level.

Level 1: At the level of the concerned course teacher

Level 2: At the level of a department committee consisting of the Head of the Department, a coordinator of internal assessment for each programme nominated by the HoD and the course teacher concerned.

Level 3: A committee with the Principal as Chairman, Dean of the concerned Faculty, HOD of concerned department and one member of the Academic council nominated by the principal every year as members.

17. **TRANSITORY PROVISION**

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

18. **REPEAL**

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

CHAPTER 2 : COURSE STRUCTURE AND SYLLABUS

1. STRUCTURE OF M.Sc. PROGRAMME IN PHYSICS 2020

Semester	Course Code	Name of the courses	No of hrs / week	Credits
I	20P1PHYT01	Mathematical methods in Physics – I	3	3
	20P1PHYT02	Classical Mechanics	4	4
	20P1PHYT03	Electrodynamics	4	4
	20P1PHYT04	Electronics	4	4
	20P1PHYP01	General Physics Practicals	10	4
		Total for Semester 1	**25**	**19**
II	20P2PHYT05	Mathematical methods in Physics – II	4	4
	20P2PHYT06	Quantum Mechanics – I	3	4
	20P2PHYT07	Condensed Matter Physics	4	4
	20P2PHYT08	Statistical Mechanics	4	4
	20P2PHYP02	Electronics Practicals	10	4
		Total for Semester 2	**25**	**20**
III	20P3PHYT09	Quantum Mechanics – II	4	4
	20P3PHYT10	Computational Physics	4	4
	20P3PHYT11	Micro Electronics and Semiconductor Devices [Elective 1]	4	4
	20P3PHYT12	Digital Signal Processing [Elective 2]	3	3
	20P3PHYP03	Computational Physics Practicals	10	4
		Total for Semester 3	**25**	**19**
IV	20P4PHYT13	Atomic and Molecular Physics	5	4
	20P4PHYT14	Nuclear and Particle Physics	5	4
	20P4PHYT15	Communication Systems [Elective 3]	5	3
	20P4PHYP04	Advanced Electronics Practicals	10	4
	20P4PHYPT	Project	-	5
	20P4PHYCV	Comprehensive viva voce	-	2
		Total for Semester 4	**25**	**22**
		Grand Total		**80**

2. M.Sc. PHYSICS SYLLABUS

INTRODUCTION

This section deals with the syllabi of all core courses, Elective courses of the MSc.

Physics program. The semester wise distribution of the courses is given.

In the semester III , Elective 1 and Elective 2 are included. Elective 3 will be dealt in semester IV.

3. CORE COURSES

SEMESTER I

20P1PHYT01: MATHEMATICAL METHODS IN PHYSICS – I

Total Credits: 3

Total Hours: 54

Course Outcomes

(i) Understand the basic theory of Vector and tensor analysis

(ii) Understand the Functions of complex variables, Elements of distribution theory and Fourier Series Successful

(iii)Analyze and expand functions in Taylor's Series, Fourier Series

UNIT I

Vector analysis (8 hrs)

1.1 Line, Surface and Volume integrals1.2 Gradient, divergence and curl of vector Functions 1.3Gauss Divergence Theorem 1.4 Stoke's Theorem1.5Green's Theorem1.6 Potential Theory1.6.1 Scalar Potential-Gravitational Potential, Centrifugal Potential

Curvilinear co-ordinates(8 hrs)

1.7 Transformation of co-ordinates1.8 Orthogonal Curvilinear co-ordinates1.9Unit Vectors in curvilinear systems1.10Arc Length and Volume Elements1.11Gradient, Divergence and Curl in orthogonal curvilinear co-ordinates1.12 Special Orthogonal co-ordinates system 1.12.1 Rectangular Cartesian Co-ordinates 1.12.2 Cylindrical Co-ordinates 1.12.3Spherical Polar Co-ordinates

UNIT II

Linear vector space(8 hrs)

1.1 Definition of linear vector space 2.2 Inner product of vectors 2.3basis sets

2.4Gram schmidt ortho normalization 2.5Expansion of an arbitrary vector2.6Schwarz inequality

Probability theory and distribution(6 hrs)

2.7 Elementary Probability Theory 2.8 Binomial Distribution2.9 Poisson Distribution

2.10 Gaussian Distribution 2.11Central Limit Theorem

UNIT III

Matrices(12hrs)

3.1 Direct Sum and Direct Product of Matrices 3.2 Diagonal matrices 3.3 Matrices inversion (Gauss Jordan Inversion Methods) 3.4 Orthogonal, unitary and Hermitian Matrices 3.5 Pauli spin matrices, Dirac matrices, Normal matrices 3.6 Cayley Hamilton Theorem 3.7 Similarity transformation 3.8 Orthogonal & Unitary Transformations 3.9 Eigen values & Eigen Vectors 3.10 Diagonalization using normalized Eigen vectors 3.11Solution of linear equation Gauss Elimination method

UNIT IV

Tensors(12 hrs)

4.1 Definition of Tensors 4.2 Basic Properties of Tensors 4.3 Covariant, Contra variant & Mixed Tensors 4.4 Kronecker delta, Levi-Civita Tensor 4.5 Metric Tensor and its properties 4.6 Tensor algebra 4.7Associated Tensors 4.8 Christoffel Symbols & their transformation laws 4.9 Covariant Differentiation 4.10Geodesics

Recommended Text Books:

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

3. Introduction to Mathematical Physics – Charles Harper, PHI
4. Vector Analysis & Tensor Analysis – Schaum's Outline Series, M.R.Speigel, Mc Graw hill
5. Mathematical methods for physics and engineering, K F Riley, M P Hobson, S J Bence, Cambridge university press.

Recommended References:

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

20P1PHYT02: CLASSICAL MECHANICS

Total Credits: 4

Total Hours: 72

Course Outcomes

(i) understand the fundamental concepts of the Lagrangian and the Hamiltonian methods and will be able to apply them to various problems;

(ii) understand the physics of small oscillations and the concepts of canonical transformations and Poisson brackets ;

(iii) understand the basic ideas of central forces and rigid body dynamics;

(iv) understand the Hamilton-Jacobi method and the concept of action-angle variables.

UNIT 1

Lagrangian formulation (14 hrs)

1.1 Review of Newtonian Mechanics: Mechanics of a Particle; Mechanics of a System of Particles; Constraints; 1.2 D' Alembert's principle and Lagrange's equations; velocity-Dependent potentials and the Dissipation Function; Lagrangian for a charged particle in electromagnetic field; 1.3 Application of Lagrange's equation to: motion of a single particle in Cartesian coordinate system and plane polar coordinate system; bead sliding on a rotating wire.1.4 Hamilton's Principle; Technique of Calculus of variations; The Brachistochrone problem. 1.5 Derivation of Lagrange's equations from Hamilton's Principle. 1.6 Canonical momentum; cyclic coordinates; Conservation laws and Symmetry properties- homogeneity of space and conservation of linear momentum; isotropy of space and conservation of angular momentum; homogeneity of time and conservation of energy; Noether's theorem(statement only; no proof is expected).

Hamiltonian formulation: (4hrs)

1.7 Legendre Transformations; Hamilton's canonical equations of motion; Hamiltonian for a charged particle in electromagnetic field. 1.8 Cyclic coordinates and conservation theorems; Hamilton's equations of motion from modified Hamilton's principle

UNIT II

Small oscillations (8hrs)

2.1 Stable equilibrium unstable equilibrium and neutral equilibrium; motion of a system near stable equilibrium-Lagrangian of the system and equations of motion. 2.2 Small oscillations- frequencies of free vibrations; normal coordinates and normal modes 2.3 system of two coupled pendula-resonant frequencies normal modes and normal coordinates ;free vibrations of CO_2 molecule- resonant frequencies normal modes and normal coordinates.

Canonical transformations and poisson brackets (10 hrs)

2.4 Equations of canonical transformations; Four basic types of generating

functions and the corresponding basic canonical transformations. Examples of canonical transformations - identity transformation and point transformation. 2.5 Solution of harmonic oscillator using canonical transformations. 2. 6 Poisson Brackets ; Fundamental Poisson Brackets; Properties of Poisson Brackets 2.7 Equations of motion in Poisson Bracket form; Poisson Bracket and integrals of motion; Poisson's theorem; Canonical invariance of the Poisson bracket.

UNIT III

Central force problem (9hours)

3.1 Reduction of two-body problem to one-body problem; Equation of motion for conservative central forces - angular momentum and energy as first integrals; law of equal areas 3.2 Equivalent one-dimensional problem –centrifugal potential; classification of orbits. 3.3 Differential Equations for the orbit; equation of the orbit using the energy method; The Kepler Problem of the inverse square law force; Scattering in a central force field - Scattering in a Coulomb field and Rutherford scattering cross section.

Rigid body dynamics (9hrs)

3.4 Independent coordinates of a rigid body; Orthogonal transformations ; Euler Angles. 3.5 Infinitesimal rotations: polar and axial vectors; rate of change of vectors in space and body frames; Coriolis effect. 3.6 Angular momentum and kinetic energy of motion about a point; Inertia tensor and the Moment of Inertia; Eigenvalues of the inertia tensor and the Principal axis transformation . 3.7 Euler equationsof motion; force free motion of a symmetrical top.

UNIT IV

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

4.1 Hamilton-Jacobi Equation for Hamilton's Principal Function; physical significance of the principal function. 4.2 Harmonic oscillator problem using the Hamilton-Jacobi method. Hamilton-Jacobi Equation for Hamilton's characteristic function 4.3 Separation of variables in the Hamilton-Jacobi Equation; Separability of a cyclic coordinate in Hamilton-Jacobi equation; Hamilton-Jacobi equation for a particle moving in a central force field(plane polar coordinates) . 4.4 Action-Angle variables; harmonic oscillator problem in action-angle variables.

Classical mechanics of relativity (6 hrs.)

4.5 Lorentz transformation in matrix form; velocity addition; Thomas precession.

4.6 Lagrangian formulation of relativistic mechanics; Application of relativistic Lagrangian to (i)motion under a constant force (ii) harmonic oscillator and (iii) charged particle under constant magnetic field.

Recommended Text Books

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

2. Classical Mechanics: G. Aruldhas, Prentice Hall 2009.

Recommended References:

1. Theory and Problems of Theoretical Mechanics (Schaum Outline Series): Murray R. Spiegel, Tata McGraw-Hill 2006.

2. Classical Mechanics : An Undergraduate Text: Douglas Gregory, Cambridge University Press.

3. Classical Mechanics: Tom Kibble and Frank Berkshire, Imperial College Press.

4. Classical Mechanics (Course of Theoretical Physics Volume 1): L.D. Landau and E.M. Lifshitz, Pergamon Press.
5. Analytical Mechanics: Louis Hand and Janet Finch, Cambridge University Press.
6. Classical Mechanics: N.C.Rana and P. S. Joag, Tata Mc Graw Hill.
7. Classical Mechanics: J.C. Upadhyaya, Himalaya Publications, 2010.
8. www.nptelvideos.in/2012/11/classicalphysics.html.

20P1PHYT03: ELECTRODYNAMICS

Total credits: 4

Total hours: 72

Course Outcomes:

(i) To understand the concepts of electrodynamics and Maxwell equations

(ii) Apply Maxwell's Equations in Various situations

UNIT 1

Electrostatics, Magnetostatics and basics of Electrodynamics(18 hrs)

1.1 Electrostatics: Electric field of a polarized object- Electric field in a - conductor-dielectric - electric displacement -Gauss's law in dielectric medium-linear dielectric medium-. Boundary condition across dielectric (ε_{r1})-dielectric (ε_{r2}), conductor-dielectric (ε_r), conductor-free space (ε_r=1) interface. 1.2 Uniqueness theorem and electrostatic potential-Solving Poisson's and Laplace equations for boundary value problems 1.3 Method of images- point charge -line charge above a grounded conducting plane. 1.4 Potential at large distance-multipole expansion due to a localized charge distribution-Electric field of a dipole. 1.5 Magnetostatics: Biot-Savart law- divergence and curl of B-Ampere's law. Magnetic vector potential-multipole expansion of vector potential-boundary conditions - Magnetic field inside matter-Magnetization (M)-Magnetic flux density (B)-Auxiliary field (H). 1.6

Electrodynamics: Electromotive force - motional emf - Faraday's law-, electrodynamic equations - displacement current. 1.7 Uniform sinusoidal time varying fields E and B and Maxwell's equations in free space and matter. Boundary conditions of electric and magnetic field 1.8 Conservation laws- continuity equation-Poynting's theorem-Maxwell's stress tensor- momentum conservation.

UNIT II

Electromagnetic waves (18 hrs)

1.1Wave equation for E and B- monochromatic plane waves- energy- momentum 1.2 Propagation of em waves through linear media- Reflection and transmission of a plane wave at normal - oblique incidence.1.3 Electromagnetic waves in a conducting medium.

Reflection at conducting surface- frequency dependence of permittivity 1.4 Dispersion of electromagnetic waves in non-conductors, conductors and plasma medium

UNIT III

Electromagnetic radiation (18 hrs)

3.1Potential formulation of electrodynamics- Gauge transformations-Coulomb and Lorentz gauge 3.2 Continuous charge distribution-Retarded potential-Jefmenko's equation.3.3 Point charges- Lienard-Wiechert potentials-Field of a point charge in motion- Power radiated by a point charge 3.4 Electric dipole radiation-magnetic dipole radiation-radiation from arbitrary distribution of charges 3.5 Radiation reaction-Abraham-Lorentz formula.

UNIT IV

Relativistic electrodynamics and Waveguides (18 Hrs)

4.1Relativistic electrodynamics 4.1.1 Structure of spacetime- Four vectors-Proper time and proper velocity- Relativistic energy and momentum-Relativistic dynamics-Minkowski force. 4.1.2 Magnetism as a relativistic phenomenon. 4.1.3 Lorentz transformation of em field- field tensor-electrodynamics in tensor notation. 4.1.4 Potential formulation of relativistic electrodynamics. 4.2 Waveguides 4.2.1 Waves between parallel planes-TE-TM-TEM waves4.2.2 Rectangular waveguide- TE-TM waves -impossibility of TEM wave. 4.2.3 Cylindrical waveguide- TE-TM waves

Recommended textbooks:

1. Introduction to Electrodynamics, David J. Griffiths, PHI.
2. Electromagnetics, John D.Kraus, McGraw-Hill International
3. Classical electrodynamics, J.D Jackson, John Wiley & Sons Inc

Recommended References:

1. Electromagnetic waves and radiating systems Edward C Jordan, Keith G Balamin, Printice Hall India Pvt.Ltd
2. Elements of Electromagnetic, Mathew N. O Sadiku, Oxford University Press

3. Antenna and wave propagation, K.D Prasad, Satyaprakashan, New Delhi
4. Electromagnetism problems with solutions, Ashutosh Pramanik, PHI.

20P1PHYT04: ELECTRONICS

Total credits: 4

Total hours: 72

Course Outcome:

(i) Understand the theoretical understanding of OP-amps

(ii) Apply the circuit for various practical applications

UNIT I

Op-amp with Negative Feedback (16 Hrs)

1.1. Differential amplifier – Inverting amplifier – Non-inverting amplifier **-**Block diagram representations – Voltage series feedback: Negative feedback – closed loop voltage gain 1.2. Difference input voltage ideally zero – Input and output resistance with feedback – Bandwidth with feedback – Total output offsetvoltagewithfeedback– Voltagefollower.1 . 3 v o l t a g e shuntfeedback amplifier: Closed loop voltage gain -inverting input terminal and virtual ground - input and output resistance with feedback – Bandwidth with feedback - Total output offset voltage with feedback.1.4. Current to Voltage Converter-Inverter. Differential amplifier with one op-amp and two op-amps.

UNIT II

The Practical Op-amp (6 Hrs)

2.1. Input offset voltage –Input bias current – input offset current – Total output offset voltage- Thermal drift.2.2. Effect of variation in power supply voltage on offset voltage – Change in input offset voltage and input offset current with time - Noise – Common mode configuration and CMRR.

General Linear Applications (with design) (14Hrs)

2.3. DC and AC amplifiers – AC amplifier with single supply voltage – Peaking amplifier – Summing, Scaling, averaging amplifiers.2.4. Instrumentation amplifier using transducer bridge. Differential input and differential output amplifier – Low voltage DC and AC voltmeter. 2.5. Voltage to current converter with grounded load – Current to voltage converter. 2.6. Very high input impedance circuit – integrator and differentiator**.**

UNIT III

Frequency Response of an Op-amp (6 Hrs)

3.1. Frequency response –Compensating networks – Frequency response of internally compensated and non-compensated op-amps – High frequency op- amp equivalent circuit.3.2. Open loop gain as a function of frequency – Closed loop frequency response – Circuit stability - slew rate.

Active Filters and Oscillators. (with design) (12Hrs)

3.3. Active filters – First order and second order low pass Butterworth filter3.4 First order and second order high pass Butterworth filter.3.5. Wide and narrow band pass filter - wide and narrow band reject filter. All pass filter – Oscillators: Phase shift and Wien-bridge oscillators. 3.6. Square, triangular and sawtooth wave generators-Voltage controlled oscillator.

UNIT IV

Comparators and Converters (8 Hrs)

4.1. Basic comparator- Zero crossing detector.4.2. Schmitt Trigger – Comparator characteristics- Limitations of op-amp as comparators. 4.3. Voltage to frequency

and frequency to voltage converters.4.4. D/A and A/D converters- Peak detector

– Sample and Hold circuit.

IC555 Timer (3 Hrs)

4.5.IC555 Internal architecture, Applications IC565-PLL, Voltage regulator ICs 78XX and 79XX

Analog Communication (7 Hrs)

4.6. Review of analog modulation – Radio receivers – AM receivers – superhetrodyne receiver.4.8. Detection and automatic gain control – communication receiver. 4.9. FM receiver – phase discriminators – ratio detector

– stereo FM reception

Recommended Text Books:

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

Recommended References:

1. Electronic Devices (Electron Flow Version), 9/E Thomas L. Floyd, Pearson
2. Fundamentals of Electronic Devices and Circuits 5th Ed. David A. Bell, Cambridge.

20P1PHYP01: GENERAL PHYSICS PRACTICALS

Total credits: 4

Total hours: 180

* *Minimum number of experiments to be done 12*

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

1. Hall Effect in Semiconductor. Determine the Hall coefficient, carrier concentration and carrier mobility.
2. Ultrasonic- acoustic optic technique-elastic property of a liquid.
3. Magnetic susceptibility of a paramagnetic solution using Quinck's tube method.
4. Curie temperature of a magnetic material.
5. Dielectric Constant and Curie temperature of ferroelectric Ceramics.
6. Draw the hysteresis curve (B – H Curve) of a ferromagnetic material and determination of retentivity and coercivity.
7. Cornu's method- Determination of elastic constant of a transparent material
8. Determination of e/m by Thomson's method.
9. Determination of e/k of Silicon.
10. Determination of Planck's constant (Photoelectric effect).
11. Measurement of resistivity of a semiconductor by four-probe method at different temperature and determination of band gap.
12. Determination of magnetic susceptibility of a solid by Guoy's method.
13. Measurement of wavelength of laser using reflection grating.
14. Fraunhoffer diffraction pattern of a single slit, determination of wavelength/slit width.
15. Fraunhoffer diffraction pattern of wire mesh, determination of wavelength/slit width.
16. Fraunhoffer diffraction pattern of double slit, determination of wavelength/slit width.
17. Diffraction pattern of light with circular aperture using Diode/He-Ne laser.
18. Fresnel diffraction pattern of a single slit.

19. Study the beam divergence, spot size and intensity profile of Diode/He-Ne laser.
20. Determine the numerical aperture of optical fibre and propagation of light through it.
21. Determine the refractive index of the material using Brewster angle setup.
22. Absorption bands of $KMnO_4$ using incandescent lamp. Determine the wave lengths of the absorption bands. Determine the wave lengths of the absorption bands by evaluating Hartman's constants.
23. Determine the co-efficient of viscosity of the given liquid by oscillating disc method.
24. Measure the thermoemf of a thermocouple as function of temperature. Also prove that Seebeck effect is reversible.
25. Determine the Young's modulus of the material of a bar by flexural vibrations.
26. Using Michelson interferometer determine the wavelength of light.
27. Study the temperature dependence of dielectric constant of a ceramic capacitor and verify Curie-Wiess law
28. Study the dipole moment of an organic molecule (acetone).
29. Determine the dielectric constant of a non-polar liquid.
30. Photograph/Record the absorption spectrum of iodine vapour and a standard spectrum.Analyze the given absorption spectrum of iodine vapour and determine the convergence limit. Also estimate the dissociation energy of iodine (wave number corresponding to the electronic energy gap = 759800 m^{-1})
31. Determine the charge of an electron using Millikan oil drop experiment.
32. Linear electro optic effect (Pockel effect), Frank Hertz experiment.
33. Frank Hertz experiment determination of ionization potential.
34. Koening's method, Poisson's ratio of the given material of bar.
35. Determination of Stefan's constant of radiation from a hot body.
36. Magneto-optic effect (Faraday Effect) - rotation of plane of polarization as a function of magnetic flux density
37. Linear electro-optic effect (Pockels effect) – half wave voltage and variation of intensity with electric field
38. Polarisation of EM waves (RF)
39. Young's double slit experiment with RF waves
40. Measurement of H21(Hydrogen) line.

41. Arc spectrum of Iron/Copper/Brass.
42. Silicon diode as a temperature sensor.
43. Electrical and thermal conductivity of copper and determination of Lorentz number.
44. Zeeman effect setup – measurement of Bohr magnetron
45. Michelson Interferometer – λ or thickness of mica.
46. Michelson Interferometer – refractive index of transparent material.
47. Michelson Interferometer – spatial and temporal coherence of laser.
48. Michelson Interferometer – Δλ of D1 and D2 lines of Sodium light.
49. Measurement of wave length of He-Ne laser light using ruler.
50. Half Shade Polari meter and Strain Viewer
51. GM counter – counting statistics/ absorption crossection/ half-life of a radioactive material
52. Clausius – Clapeyron : Determination of specific enthalpy
53. Hydrogen Spectrum – Determination of Rydberg constant
54. Specific rotation of Sugar solution.
55. Refractive index of a liquid (or transparent solid) using laser and Grating.
56. e/m of an electron by JJ Thomson experiment.
57. Millikan’s oil drop experiment – determination of electronic charge
58. Photo electric effect - determination of planks constant.
59. Frank-Hertz Experiment.
60. Determination of diamagnetic and paramagnetic susceptibility of glass or water
61. ESR experiment determination of g factor.
62. Determination of ferromagnetic Curie temperature.
63. Magnetic Susceptibility - Gouy's method

References

R1. Advanced practical physics for students, B.L Worsnop and H.T Flint, University of California.

R2. A course on experiment with He-Ne Laser, R.SSirohi, John Wiley & Sons (Asia) Pvt.ltd

R3. Kit Developed for doing experiments in Physics- Instruction manual, R.Srenivasan ,K.R Priolkar, Indian Academy of Sciences.

R4. Advanced Practical Physics, S.P singh, PragatiPrakasan,

R5. Practical Physics, Gupta, Kumar, PragatiPrakasan.

R6. An advanced course in Practical Physics, D.Chattopadhayay, C.R Rakshit, New Central Book Agency Pvt. Ltd: ****for error analysis only.**

SEMESTER II

20P2PHYT05:MATHEMATICAL METHODS IN PHYSICS – II

Total Credits: 4

Total Hours: 72

Course outcomes:

(i) Understand the concepts of Laplace and Fourier transforms.

(ii) Apply Fourier series to solutions of partial differential equations.

(iii) Apply methods of functions of complex variables for calculations of integrals

UNIT 1

Complex analysis (18 hrs)

1.1Functions of a complex variable 1.2 Analytic functions1.3Cauchy-Riemann equation1.4Integration in a complex plane1.5Cauchy Theorem 1.6 Cauchy's integral formulas 1.7 Taylor expansion & Laurent expansion1.8 Residue, poles1.9 Cauchy residue theorem1.10 Cauchy's principle value theorem 1.11 Evaluation of integrals

UNIT II

Integral transforms (18 hrs)

2.1 Fourier Series 2.2 Application of Fourier series 2.2.1 Square Wave 2.2.2 Full Wave Rectifier 2.3 Fourier Integral 2.4 Fourier Transform 2.4.1 Finite Wave Train 2.5 Convolution Theorem of parseval's relation2.6Momentum representation 2.6.1 Hydrogen atom 2.6.2 Harmonicoscillator 2.7 Laplace Transform, Inverse Laplace transform 2.8 Earth Mutation 2.9 Damped Oscillator 2.10 LCR circuit

UNIT III

Special functions and differential equations (18 hrs)

3.1 Gamma Function 3.2 Beta Function 3.3 Symmetry Property of Functions 3.4 Evaluation of Beta functions3.5 Other forms of Beta Functions --Transformation of P Functions 3.6 Evaluation of Gamma Functions 3.7 Other forms of Gamma Functions-

Transformation of Gamma Functions 3.8 Relation between Beta and Gamma Functions 3.9 Evaluation of Integrals 3.10 Bessel's Differential Equation, 3.11 Legendre Differential Equation 3.12 Associated Legendre Differential Equations 3.13 Hermite Differential Equations 3.14 Laguerre Differential Equations (Generating function, recurrence relation, orthogonality condition, Rodrigues formulae for all functions)

UNIT IV

Partial differential equations (18 hrs)

4.1 Characteristics of boundary conditions for partial differential equation 4.2 Solution of partial differential equations by the method of separation of variables in Cartesian, cylindrical and spherical polar co-ordinates 4.3 Solution of Laplace equation in cartesian, cylindrical and spherical polar co-ordinates4.4Heat equation in Cartesian co-ordinates 4.5 Non-Homogeneous equation 4.6 Green's function 4.7 Symmetry of Green's Function4.8Green's Function for Poisson Equation, Laplace equation, Helmholtz equation 4.9Application of Greens equation in scattering problem

Recommended Text Books:-

1. Mathematical methods for Physicists, G.B. Arfken& H.J. Weber 5th edition, Academic Press.

2. Mathematical Physics , V.Balakrishnan,Ane Books Pvt Limited

Recommended Reference Books:

1. Advanced Engineering Mathematics E.Kreyszig 7thedition John Wiley
2. Mathematical Physics, B.S.Rajput,Y.Prakash 9th edition PragatiPrakashan
3. Mathematical Physics,B.D.Gupta ,Vikas Publishing House
4. Matrices and tensors in Physics,A.W.Joshi
5. Mathematical Physics , P.K.Chatopadhyay ,New Age International Publishers
6. Mathematical Physics, Sathyaprakash, Sultan Chand & Sons

20P2PHYT06: QUANTUM MECHANICS-I

Total Credits: 4

Total Hours: 54

Course Outcomes:

(i) understand the fundamental concepts of the Dirac formalism

(ii) understand how quantum systems evolve in time;

(iii) understand the basics of the quantum theory of angular momentum.

UNIT I

Basics Formulation of Quantum Mechanics (20 hours)

1.1 Development of the idea of state vectors from sequential Stern-Gerlach experiments ;Dirac notation for state vectors: ket space, bra space and inner products; 1.2 Operators; Associative axiom; outer product; 1.3 Hermitian adjoint; Hermitian operator; Eigenkets and eigenvalues of Hermitian operators. Eigenkets of observables as base kets; concept of complete set. Projection operators. 1.4 Matrix representations of operators, kets and bras 1.5 Measurements in quantum mechanics; expectation value ; Compatible observables and existence of simultaneous eigenkets; General Uncertainty Relation. 1.6 Unitary operator, change of basis and transformation matrix, unitary equivalent observables. 1.7 Position eigenkets, infinitesimal translation operator and its properties, linear momentum as generator of translation, canonical commutation relations. Wavefunction as an expansion coefficient; eigenfunctions, momentum eigen function 1.8 momentum space wavefunctions and the relation between wavefunctions in position space and momentum space. Gaussian wave packet- compuatation of dispersions in position and momentum.

UNIT II

Quantum Dynamics (16 hours)

2.1 Time evolution operator and its properties 2.2 Schrodinger equation for the time evolution operator; solution of the Schrodinger equation for different time dependences of the Hamiltonian 2.3 Energy eigenkets; time dependence of expectation values 2.4 time evolution of a spin half system and spin precession 2.5 Correlation amplitude; time-energy uncertainty relation and its interpretation.

2.6 Schrodinger picture and Heisenberg picture; behavior of state kets and observables in Schrodinger and Heisenberg pictures; Heisenberg's equation of motion 2.7 Ehrenfest's theorem; time evolution of base kets; transition amplitudes. 2.8 Simple Harmonic Oscillator: Energy eigenvalues and energy eigenkets.

UNIT III

Theory of Angular Momentum (14 hours)

3.1 Non-commutativity of rotations around different axes; the rotation operator; fundamental commutation relations for angular momentum operators 3.2 rotation operators for spin half systems; spin precession in a magnetic field 3.3 Pauli's two component formalism; 2X2 matrix representation of the rotation operator 3.4 ladder operators; eigenvalue problem for angular momentum operators 3.5 matrix representation of angular momentum operators.3.6 Orbital angular momentum ; orbital angular momentum as a generator of rotation 3.7 Addition of orbital angular momentum and spin angular momentum; addition of angular momenta of two spin-1/2 particles. General theory of Angular Momentum addition-Computation of Clebsch - Gordon coefficients.

UNIT IV

The Hydrogen Atom (4 hours)

4.1 Behaviour of the radial wavefunction near the origin; the Coulomb potential and the hydrogen atom; hydrogenicwavefunctions; degeneracy in hydrogen atom.

Recommended Text Books:

1. Modern Quantum Mechanics : J. J. Sakurai, Pearson Education.
2. A Modern Approach to Quantum Mechanics: J S Townsend, Viva Books.

Recommended References:

1. Quantum Mechanics (Schaum's Outline) :Yoav Peleg *etal*. Tata Mc Graw Hill Private Limited, 2/e.

2. Quantum Mechanics: 500 Problems with Solutions: G Aruldhas, Prentice Hall of India.

3. Quantum Mechanics Demystified: David McMohan, McGrawHill 2006.

4. Introductory Quantum Mechanics: Richard L Liboff, Pearson Education .

5. Introduction to Quantum Mechanics: D.J. Grifith, Pearson Education.

6. Quantum Mechanics : V. K. Thankappan, New Age International.

7. Quantum Mechanics: An Introduction: Walter Greiner and Allan Bromley, Springer.

8. Quantum Mechanics : Non-Relativistic Theory(Course of Theoretical Physics Vol3): L. D. Landau and E. M. Lifshitz, Pregamon Press.

9. The Feynman Lectures on Physics Vol3, Narosa.

10. www.nptel/videos.in/2012/11/quantum-physics.html

11. https://nptel.ac.in/courses/115106066/

20P2PHYT07: CONDENSED MATTER PHYSICS

Total Credits: 4

Total Hours: 72

Course Outcomes

(i) Apply the concept of X-ray diffraction to interpret crystalline structure.
(ii) Compare different solids using band theory.
(iii) Distinguish magnetic materials

UNIT 1

Wave Diffraction and the Reciprocal Lattice (5Hrs)

1.1 Diffraction of waves by crystals-Bragg's Law- **1.2** Scattered wave amplitude-reciprocal lattice vectors- diffraction condition-Laue equations-Ewald construction-**1.3** Brillouin zones- reciprocal lattice to SC, BCC and FCC lattices-properties of reciprocal lattice- **1.4** diffraction intensity - structure factor and atomic form factor-physical significance.

Crystal Symmetry (7Hrs)

1.5 Crystal symmetry-symmetry elements in crystals-point groups, space groups

1.6 Ordered phases of matter-translational and orientational order- kinds of liquid crystalline order-Elements of Quasi crystals

Free Electron Fermi Gas (12 Hrs)

1.7. Energy levels in one dimension-quantum states and degeneracy- density of states-

1.8 Fermi-Dirac statistics -Effect of temperature on Fermi-Dirac distribution –**1.9** Free electron gas in three dimensions- **1.10** Heat capacity of the electron gas- relaxation time and mean free path - **1.11** Electrical conductivity and Ohm's law - Widemann-Franz-Lorentz law - electrical resistivity of metals.

UNIT II

Energy Bands (8 Hrs)

2.1 Nearly free electron model- Origin of energy gap-Magnitude of the Energy Gap-

2.2 Bloch functions – **2.3** Kronig-Penney model –**2.4** Wave equation of election in a periodic potential-Restatement of Bloch theorem-Crystal momentum of an Electron-Solution of the central equations-**2.5** Brillouin zone- construction of Brillouin zone in one and two dimensions – extended, reduced and periodic zone scheme of Brillouin zone (qualitative idea only) - **2.6** Effective mass of electron –**2.7** Distinction between conductors, semiconductors and insulators.

Semiconductor Crystals (10 Hrs)

2.8. Band Gap-**2.9.**Equations of motion-Effective mass-Physical interpretation of effective mass - Effective mass in semiconductors-Silicon and Germanium-**2.10** Intrinsic carrier concentration- **2.11** Impurity conductivity-Thermal ionization of Donors and Acceptors-Thermoelectric effects-semimetals-super lattices-Bloch Oscillator-Zener tunnelling.

UNIT III

Phonons

Crystal Vibrations and Thermal Properties (16 Hrs)

3.1 Vibrations of crystals with monatomic basis –First Brillouin zone-Group Velocity-

3.2 Two atoms per Primitive Basis – **3.3** Quantization of elastic waves –**3.4** Phonon momentum-**3.5** Inelastic scattering of phonons.-**3.6** Phonon Heat Capacity-Plank distribution-Density of States in one and three dimensions-Debye model for density of states-Debye T^3 Law-Einstein Model for Density of states- **3.7** Anharmonic Crystal interactions-Thermal Expansion- **3.8** Thermal Conductivity-thermal resistivity of phonon gas-Umklapp Processes-Imperfections

UNIT IV

Magnetic Properties of Solids (14 hrs)

4.1 Quantum theory of paramagnetism–Hunds rules-crystal field splitting-spectroscopic splitting factor-**4.2** Cooling by adiabatic demagnetization – Nuclear Demagnetization- **4.3** Ferromagnetic order-Curie point and the exchange integral-Temperature dependence of the saturation-Magnetization-Saturation Magnetization at absolute Zero-**4.4** Magnons-Quantization of spin waves-Thermal excitation of Manganons-**4.5** Neutron Magnetic Scattering-**4.6** Ferromagnetic order-curie temperature and Susceptibility-**4.7** Antiferromagnetic order-susceptibility below Neel-Temperature-**4.8** Ferromagnetic domains-Anisotropic Energy-transition region between Domains-origin of domains -Corecivity and Hysteresis-**4.9** Single Domain Particles-Geomagnetism and Biomagnetism-Magnetic scope microscopy **4.10** Elements of superfluidity.

Recommended Textbooks:

1. Introduction to Solid State Physics, Charles Kittel, Wiely, Indian reprint (2015).
2. Solid State Physics, A.J. Dekker, Macmillan & Co Ltd. (1967)
3. Introduction to Solids, L V Azaroff, McGRAW-HILL BOOK COMPANY, INC.New York (1960)
4. Solid State Physics: Structure and properties of materials, M.A. Wahab, Narosa 2nd Edn. (2010)
5. Solid State Physics, S.O. PIllai, New age International Publishers, 7th Edition (2017)

Recommended References:

1. Solid State Physics, N.W. Ashcroft & N.D. Mermin, Cengage Learning Pub.11th IndianReprint (2011).
2. Solid State Physics, R.L. Singhal, KedarNath Ram Nath& Co (1981)
2. Elementary Solid State Physics, M. Ali Omar, Pearson, 4th Indian Reprint (2004).
3. Solid State Physics, C.M. Kachhava, Tata McGraw-Hill (1990).
4. Elements of Solid State Physics, J. P. Srivastava, PHI (2004)
5. Solid State Physics, Dan Wei, Cengage Learning (2008)
6. Solid State Physics, J S Blackemore, Cambridge University Press (1985)
2. 8.Electronic Properties of Crystalline Solids, Richard Bube, Academic Press New York (1974)

20P2PHYT08: STATISTICAL MECHANICS

Total Credits: 4

Total Hours: 72

Course Outcomes

(i) Understand the concepts of probability.

(ii) Apply to the problems related to classical mechanics & thermodynamics using statistical mechanics

UNIT I (22 hrs)

1.1. The Statistical Basis of Thermodynamics1.1.1. Macroscopic and microscopic states.1.1.2.Connection between thermodynamics and statistics.1.1.3.Classical ideal gas.1.1.4.Entropy of mixing and Gibbs paradox.1.1.5. Correct enumeration of micro states.1.2. Elements of Ensemble Theory 1.2.1. Phase space of a classical system.

1.2.2. Liouville's theorem.1.2.3. Micro-canonical ensemble.1.2.4. Quantum states and phase space.1.3. Canonical ensemble.1.3.1. Equilibrium between a system and a heat reservoir.1.3.2. System in canonical ensemble.1.3.3. Physical significance of statistical quantities in canonical ensemble.1.3.4. Classical systems.1.3.5. Energy fluctuations in canonical ensemble.1.3.6.Equipartition theorem.

UNIT II(18 hrs)

2.1. Grand canonical Ensemble2.1.1. Equilibrium between system and energy-particle reservoir.2.1.2.A system in grand canonical ensemble.2.1.3.Physical significance of various statistical quantities.2.1.4. Examples.2.1.5. Fluctuations in grand canonical ensemble.2.2. Formulation of Quantum Statistics2.2.1.Quantum mechanical ensemble theory.2.2.2.Density matrix.2.2.3.Statistics of various ensembles.2.2.4.Examples (an electron in magnetic fields, free particle in a box). 2.2.5. A system composed of indistinguishable particles.

UNIT III(22hrs)

3.1. Quantum Theory of Simple Gases3.1.1. Ideal gas in quantum-micro canonical ensemble.3.1.2.Ideal gas in other quantum mechanical ensembles.3.1.3.Statistics of the occupation numbers3.2.Ideal Bose Systems3.2.1.Thermodynamic behaviour of ideal Bose gas.3.2.2.Thermodynamics of black body radiation. The field of sound waves. 3.3.

Ideal Fermi Systems3.3.1.Thermodynamics of ideal Fermi gas. 3.3.2. The Electron gas in metals.

UNIT IV(10 hrs)

4.1. Phase Transitions4.1.1. Phases.4.1.2. Thermodynamic potentials, 4.1.3. Approximation.4.1.4. First order phase transition.4.1.5. Clapeyron equation.

Recommended Text books:

1. Text book- R.K. Pathria, Statistical Mechanics, second edition (1996), Butterworth, Heinemann. (For Modules I, II and III.)
2. R Bowley and M. Sanchez, Introductory Statistical Mechanics, second edition, Oxford University Press. (For Module IV)

Recommended Reference Books:

1. Kerson Huang, Statistical Mechanics, John Wiley and Sons (2003).
2. F. Rief, Fundamentals of Statistical and Thermal Physics, McGraw Hill (1986).
3. D. Chandler, Introduction to Statistical Mechanics, Oxford University Press (1987)
4. L.D Landau and E.M Lifshitz, Statistical Physics (Vol-1),3rd Edition. Pergamon Press(1989)
5. Yung-Kuo Lim, Problems and Solutions in Thermodynamics and Statistical Mechanics, World Scientific (1990).

20P2PHYP02:ELECTRONICS PRACTICAL

Total credit: 4

Total hours: 180

* *Minimum number of experiments to be done 12*

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

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

1 Op-Amp parameters (i) Open loop gain (ii) input offset voltage (iii) input bias current (iv)) CMRR (v) slew rate (vi) Band width

2. Design and construct an integrator using Op-Amp (*μA741)*, draw the input output curve and study the frequency response.
3. Design and construct a differentiator using Op-Amp (*μA741) for sin wave and square wave input* and study the output wave for different frequencies.
4. Design and construct a logarithmic amplifier using Op-Amp (*μA741) and study the output wave form*.
5. Design and construct a square wave generator using Op-Amp (*μA741) for a frequency f_0*.
6. Design and construct a triangular wave generator using (*μA741) for a frequency f_0*.
7. Design and construct a saw tooth wave generator using Op-Amp (*μA741)* generator.
8. Design and construct an Op-Amp Wien bridge oscillator with amplitude stabilization and study the output wave form.
9. Design and construct a Schmidt trigger using Op-Amp μA741*, plot of the hysteresis curve.*
10. Design and construct an astable multivibrator using *μA741 with duty cycle other than 50%*
11. Design and construct a RC phase shift oscillator using *μA741for a frequency f_0*.

12. Design and construct a first and second order low pass Butterworth filter using *μA741 and plot the frequency response curve.*
13. Design and construct a first and second order high pass Butterworth filter using *μA741 and study the frequency response.*
14. Design and construct a first order narrow band pass Butterworth filter using *μA741.*
15. Solving differential equation using *μA741*
16. Design and construct ccurrent to voltage and voltage to current converter (*μA741*)
17. Astable multivibrator using 555 timer, study the positive and negative pulse width and free running frequency.
18. Monostable multivibrator using 555 timers and study the input output waveform.
19. Voltage controlled Oscillator using 555 timer
20. Design and construct a Schmitt Trigger circuit using IC 555.
21. Design and test a two stage RC coupled common emitter transistor amplifier and find th bandwidth, mid-frequency gain, input and output impedance.
22. Design and test a RC phase shift oscillator using transistor for a given operating frequency.
23. Voltage controlled Oscillator using transistor
24. Study the function of (i) analog to digital converter using IC 0800 (ii) digital to analog converter DAC 0808
25. Study the application of op-Amp (*μA741) as a d*ifferential amplifier.
26. Solving simultaneous equation using op-Amp (*μA741).*
27. MOSFET Characteristics
28. Opamp integrator and differentiator
29. Determination of ionic conductivity
30. Opto coupler characteristics
31. Photo transistor characteristics
32. PSpice simulation of electronic circuits (eg: amplifiers, and other circuits)

33. PSpice simulation of electronic circuits (eg: filters, and other circuits)
34. Study of LCR Resonant Circuit

References:

R1. Op-Amp and linear integrated circuit

Ramakanth A Gaykwad, Eastern Economy Edition, ISBN-81-203-0807-7 **R2.** Electronic Laboratory Primer a design approach

S. Poornachandra, B.Sasikala, Wheeler Publishing, New Delhi

R3. Electronic lab manual Vol I, K ANavas, Rajath Publishing

R4. Electronic lab manual Vol II, K ANavas, PHI eastern Economy Edition

R5. Electronic lab manual Vol II, Kuriachan T.D, Syam Mohan, Ayodhya Publishing

R6. An advanced course in Practical Physics, D.Chattopadhayay, C.R Rakshit, New Central

Book Agency Pvt. Ltd: ****For error analysis only.**

SEMESTER III

20P3PHYT09: QUANTUM MECHANICS-II

Total Credits: 4

Total Hours: 72

Course Outcomes

(i) understand the different stationary state approximation methods and be able to apply them to various quantum systems;

(ii) understand the basics of time-dependent perturbation theory and its application to semi-classical theory of atom-radiation interaction;

(iii) understand the theory of identical particles and its application to helium;

(iv) understand the idea of Born approximation and the method of partial waves. Also, this course will introduce the student to the basic concepts of relativistic quantum mechanics.

UNIT I

Approximation Methods for Stationary States(18 hrs)

1.1 Non-degenerate Perturbation Theory: First order energy shift; first order correction to the energy eigenstate; second order energy shift. Harmonic oscillator subjected to a constant electric field. 1.2 Degenerate Perturbation theory First order Stark effect in hydrogen; Zeeman effect in hydrogen and the Lande g-factor.

1.3 The variational Method; Estimation of ground state energies of harmonic oscillator and delta function potential 1.4 Ground State of Helium atom ; Hydrogen Molecule ion.

1.5 The WKB method and its validity; The WKB wavefunction in the classical region; non-classical region ; connection formulas(derivation not required) 1.6 Potential well and quantization condition; the harmonic oscillator. 1.7 Tunneling; application to alpha decay.

UNIT II

Time-Dependent Perturbation Theory (18 hrs)

2.1 Time dependent potentials; interaction picture; time evolution operator in interaction picture; Spin Magnetic Resonance in spin half systems 2.2 Time dependent perturbation theory; Dyson series; transition probability 2.3 constant perturbation; Fermi's Golden Rule ; Harmonic perturbation 2.4 interaction of atom with classical radiation field; absorption and stimulated emission; electric dipole approximation; photoelectric effect 2.5 Energy shift and decay width.

UNIT III

Identical Particles andScattering Theory (18hrs)

3.1 Bosons and fermions; anti-symmetric wave functions and Pauli's exclusion principle. 3.2 The Helium Atom.3.3 The Asymptotic wave function - differential

scattering cross section and scattering amplitude 3.4 The Born approximation-scattering amplitude in Born approximation; validity of the Born approximation;

Yukawa potential ; Coulomb potential and the Rutherford formula. 3.5 Partial wave analysis- hard sphere scattering; S-wave scattering for finite potential well; Resonances and Ramsauer-Townsend effect .

UNIT IV

Relativistic Quantum Mechanics(18 hrs)

4.1 Klein-Gordon Equation; continuity equation and probability density in Klein-Gordon theory. 4.2 Non-relativistic limit of the Klein-Gordon equation 4.3 Solutions of the Klein –Gordon equation for positive, negative and neutral spin0 particles; Klein-Gordon equation in the Schrodinger form.

4.4 Dirac Equation in the Scrodinger form; Dirac's matrices and their properties 4.5 Solutions of the free particle Dirac equation; single particle interpretation of the plane waves; velocity operator; *zitterbewegung*4.6 Non-relativistic limit of the Dirac equation; spin of Dirac particles; Total angular momentum as a constant of motion. 4.7 Negative energy states and Dirac's hole theory.

Recommended Text Books:

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

Recommended References:

1. Quantum Mechanics (Schaum's Outline Series): Yoav Peleg etal., Tata McGraw Hill .Education Private Limited, 2/e.
2. Quantum Mechanics: 500 Problems with Solutions: G Aruldhas, Prentice Hall of India.
3. Problems and Solutions in Quantum Mechanics: Kyriakos Tamvakis, Cambridge University Press.
4. Introductory Quantum Mechanics: Richard L Liboff, Pearson Education.
5. Quantum Mechanics: V. K. Thankappan, New Age International.
6. A Textbook of Quantum Mechanics: P M Mathews and R Venkatesan, Tata McGraw Hill.
7. Quantum Mechanics: Non Relativistic Theory (Course of Theoretical Physics Course Vol3) : L. D. Landau and E. M. Lifshitz, Pregamon Press.
8. Relativistic Quantum Mechanics: James D Bjorken and Sidney D Drell, Tata McGraw Hill 2013
9. www.ntpel/videos.in/2012/11/quantum-physics.html
10. https://nptel.ac.in/courses/115106066/

20P3PHYT10: COMPUTATIONAL PHYSICS

Total Credits:4

Total Hours: 72

Course Outcomes

(i) To understand the basic idea about the techniques used in physics

(ii) Apply to problems with the help of computers when they cannot be solved analytically with pencil and paper since the underlying physical system is very complex.

(iii) Help students to evaluate and develop their own Algorithms of every method described in the syllabus.

UNIT I
Curve Fitting and Interpolation (20Hrs)

1.1 The least squares method for fitting a straight line, 1.2 The least squares method for fitting a parabola, 1.3 The least squares method for fitting a power curves, 1.4 The least squares method for fitting an exponential curves. 1.5 Interpolation - Introduction to finite difference operators,1.6 Newton's forward and backward difference interpolation formula, 1.7 Newton's divided difference formula, 1.8 Cubic spline interpolation.

UNIT II

Numerical Differentiation and Integration(16 Hrs)

2.1 Numerical differentiation, 2.2 cubic spline method,2.3errors in numerical differentiation, 2.4 Integration of a function with Trapezoidal Rule, 2.5 Simpson's 1/3 2.6 Integration of a function with Simpson's 3/8 Rule and error associated with each.

2.7Relevant Algorithms for each.

UNIT III

Numerical Solution of Ordinary Differential Equations (20Hrs)

3.1 Euler method, 3.2 modified Euler method 3.3 Runge - Kutta 4th order methods –

3.4 adaptive step size R-K method, 3.5Higher order equations. 3.6 Concepts of stability.

Numerical Solution of System of Equations

3.7 Gauss-Jordan elimination Method, 3.8 Gauss-Seidel iteration method, 3.9 Gauss elimination method 3.10 Gauss-Jordan method to find inverse of a matrix. 3.11 Power method 3.12 Jacobi's method to solve eigenvalue problems.

UNIT IV

Numerical solutions of partial differential equations (16Hrs)

4.1 Elementary ideas and basic concepts in finite difference method, 4.2 Schmidt Method, 4.3 Crank - Nicholson method,4.4 Weighted average implicit method.

4.5 Monte Carlo evaluation of integrals, 4.6 Buffon's needle problem, 4.7 requirement for random number generation.

Recommended Text Books:

1. Numerical Methods for Scientists and Engineers , K SankaraRao,PHI Pvt. Ltd .
2. Introductory Methods of Numerical Analysis, S.S. Sastry, PHI Pvt. Ltd.
3. Mathematical Methods, G. Shanker Rao, K. Keshava Reddy, I.K. International Publishing House, Pvt. Ltd.

Recommended Reference Books:

1. .An Introduction to Computational Physics, Tao Pang, Cambridge University Press
2. Numerical methods for scientific and Engineering computation M.K Jain,S.R.KIyengar, R.K. Jain, New Age International Publishers
3. Computer Oriented Numerical Methods, V. Rajaraman, PHI, 2004.
4. Numerical Methods, E. Balagurusami, Tata McGraw Hill, 2009.
5. Numerical Mathematical Analysis, J.B. Scarborough, 4PthP Edn, 1958
6. Explorations in Monte Carlo Methods Ronald W Shonkwiler and Franklin Mendivil , Springer

ELECTIVE 1

20P3PHYT11: MICROELECTRONICS AND SEMICONDUCTOR DEVICES

Credits: 3

Number of hours: 72

Course Outcomes

(i) Understand the architecture and instruction set of basic microprocessors

(ii) Apply the knowledge of semiconductor fabrication processes to work in industry in the area of semiconductor devices.

UNIT I

Introduction to microprocessors (20Hrs)

1.1Microprocessor organization- General organization of a microprocessor based microcomputer system 1.2 Memory organization – main memory array –memory management, cache memory, virtual memory 1.3 Input/output operation - Standard

I/O – memory mapped I/O- interrupt driven I/O –DMA1.4 8085 Microprocessor – Architecture1.5 8085 addressing modes, instruction set, Pin out diagram,1.6 Simple programming concepts.

UNIT II

8086 Microprocessor (16Hrs)

2.1 The Intel 8086- Architecture - MN/MX modes –Pin diagram 2.2 8086 addressing modes 2.3 8086 instruction set- instruction format- assembler directives and operators 2.4.Programming with 8086- Familiarisation with Debug utility2.5. Interfacing memory and I/O ports.

UNIT III

Microcontrollers (19 Hrs)

3.1 Introduction to microcontrollers and embedded systems 3.2 Comparison of microprocessors and microcontrollers 3.3 The 8051 architecture - Register set of 8051

– important operational features 3.4 I/O pins of 8051, ports and circuits - external memory - counters and timers – interrupts 3.5 Instruction set of 8051 - Basic programming concepts 3.6 Applications of microcontrollers - (basic ideas) – Embedded systems(basic ideas)

UNIT IV

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

4.1 Metal-semiconductor - Schottky barrier diode - qualitative characteristics – ideal junction properties- 4.2 Current voltage relationship, Comparison with junction diode 4.3 Metal semiconductor ohmic contact 4.4 Idealnon rectifying barriers – tunneling barrier – specific contact resistances 4.5 Semiconductor hetero-junctions – hetero-junction materials – energy band diagram –Two dimensional electron gas 4.6equilibrium electrostatics – current voltage characteristics.

Recommended Text books:

1. Microprocessor Architecture Programming and Applications with 8085, R.S. Gaonkar – Penram int. Pub. Mumbai
2. Fundamentals of Microprocessors and microcomputers- B. Ram (DhanpatRaiPub.)
3. Microprocessors and Microcomputer based system design, H. Rafiquizzaman, Universal Book stall, New Delhi
4. The 8051 microcontroller, Architecture Programming and Applications, Kenneth J Ayala- Penram Int. Pub. Mumbai
5. Semiconductor Physics and Devices, Donald A. Neamen, McGraw Hill

Recommended References:

1. 0000 to 8085 Introduction to Microprocessors for Engineers and Scientists.- P.K. Gosh & P.R. Sridhar, PHI
2. Advanced microprocessors and peripherals, A.K. Ray & K.M. Burchandi –TMH
3. Microprocessor and microcontroller, R. Theagarajan- SCITECH Publications India Pvt. Ltd.

4. Microprocessor and Peripherals, S.P. Chowdhury& S. Chowdhury- SCITECH Publications.

5. Operating system Principles, Abraham Silberschatz& Peter Baer Galvin & Greg Gagne, John Wiley

6. Solid state electronic devices, Streetman and Banerjee, PHI (2010).

7. Physics of Semiconductor Devices, Michael Shur, PHI (2002).

8. Introduction to Semiconductor materials and Devices, M.S. Tyagi, John Wiley and Sons (2000)

ELECTIVE 2

20P3PHYT12: DIGITAL SIGNAL PROCESSING

Total Credits: 3

Total Hours: 54

Course Outcomes

(i) To understand the discrete time systems and to learn about FFT algorithms

(ii) To understand the design techniques for FIR and IIR digital filters

(iii) Apply techniques such as FFT for industry/research related problems

UNIT I

Discrete time signals and Linear systems (16 Hours)

1.1 Examples of Signals -1.2 Classification of signals -1.3 System-1.4 Examples of discrete time 1.5System models 1.5-Signal processing-1.6 Advantages ,Limitations and applications of DSP- 1.7 Elementary continuous time signals-1.8 Representation of discrete time signals-1.9 Elementary discrete time signals-1.10 Classification of discrete time signals-1.11 Operation on signals-1.12 Sampling and Aliasing -1.13 Discrete time system-Classifications-1.14 Representation of an arbitrary sequence-1.15 Impulse response and convolution sum-properties-Causality-1.15 FIR,IIR, stable and unstable systems-1.16Correlation of two sequences.

UNITII

DSP Techniques (10 Hrs)

2.1Frequency analysis of Discrete Time signals – 2.2 Discrete frequency spectrum and frequency range -2.3 Development of DFT from DTFT – 2.4 Definition of Discrete Fourier transform-2.5 Frequency spectrum using DFT- 2.6 Properties of Discrete Fourier transform-2.7Relationship of the DFT to other transforms-Properties-2.8 Fast Fourier Transform (FFT) – 2.9Decimation in time algorithm –Radix- 2 FFT - 8 point DFT using Radix -2 DIT FFT

UNIT III

Z Transform (12 Hrs)

3.1 Z-Transform & ROC -properties -3.2 Z transform of finite duration ,infinite duration and two sided sequence – 3.3 System function – 3.4 Poles and Zeros- Stability criterion 3.5 (Problems based on determination of Z trasform,ROC and Properties are expected)

UNIT IV

Digital Filters (16 Hrs)

4.1 IIR filters-frequency selective filters-4.2 Design of digital filters from Analog filters-4.3 Analog low pass filter design-4.4 Design of IIR filters from Analog filters-4.5Approximation of derivatives -4.6 Design of IIR filter using impulse invariance Technique-4.7 Bilinear transformation-4.8Direct form I structure of IIR systems-4.9Cascade form realization of IIR systems-4.10 Realization of digital filters-4.11 Direct form I realization-4.12 Direct form II realization-4.13 FIR filters-4.14 Linear phase FIR filters-4.15 Design of FIR filter using rectangular window-4.16The Fourier series method of designing FIR filters

Recommended Text Books:

1. Digital Signal Processing, Fourth edition P. Ramesh Babu, Scitech
2. Digital signal Processing – A NagoorKani, Tata Mc Grow Hill
3. Digital Signal Processing: Theory, Analysis and Digital-Filter Design, B. Somanathan Nair, PHI (2004)
4. Digital Signal Processing, Alan V. Oppenheim & R.W. Schafer, PHI
5. Digital Signal Processing -A practical Guide for scientists and Engineers- Steven W Smith
6. Digital signal processing -Hand book – Vijay K Madisetty & Douglas B Williams

Recommended References:

1. Computer applications in physics, Suresh Chandra, Alpha Science International (2006)

2. Digital Signal Processing, S. Salivahanan, A. Vallavaraj, C.Gnanapriya, TMH

3. Signals and Systems, Allan V. Oppenheim, Alan S. Willsky, S.H.Nawab, PHI

4. Digital Signal Processing, John G. Proakis, Dimitris G. Manolakis, PHI

5. Digital signal processing, Sanjay Sharma, S.K. Kataria& Sons, 2010

6. Mathematical Methods for Physicists,G.B.Arfken&H.J.Weber.Elsavier, Academic Press

7. Digital signal; processing – V K Khanna S.Chand

8. Digital Signal Processing and Applications - Dag Stranneby&William Walker

20P3PHYP03: COMPUTATIONAL PHYSICS PRACTICALS

Note

1. Develop algorithm / Flowchart for all experiments
2. Codes can be developed in any package / programming language. Candidate should be trained to explain parts of the codes used.
3. Plotting can be done in any plotting package and can be separate from the programming package / environment.
4. Verify numerical results with analytical results wherever possible.
5. Repeat experiments for various initial values / functions / step-sizes.
6. Training may be given to use methods discussed below to solve real physics problems.

(Minimum of 12 Experiments should be done with C++ / FORTRAN as the programming language)

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

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

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

4. Newton’s forward interpolation / backward interpolation.

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

Steam Table

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

Temperature: 145 C (This is only a sample data. Students should be capable to handle another set of data from any other physical phenomena)

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

   θ) for a given value.

7. Numerical integration by the trapezoidal rule.

8. Using the trapezoidal rule, calculate the inner surface area of a parabolic reflecting mirror. (length of semi major axis , semi minor axis and height are to be given)

9. Numerical integration by the Simpson rule (1/3).
10. Numerical integration by the Simpson rule (3/8).

11. Fit a straight line using method of least square to a set of given data without using any built in function of curve fitting. Compare your result with any built in curve fitting technique.

12. Find out the normal equations and hence fit a parabola using method of least square to a set of given data without using any built in function of curve fitting. Compare your result with any built in curve fitting technique.

12. Fit a exponential curve to the given set of data using method of least square with out using any built in curve fitting technique. Compare your result with any built in curve fitting technique.

13. Study the given function as a sum of infinite series. Compare your value with the available standard value.

14. Numerical solution of ordinary first-order differential equations using the Euler methods or the fourth order Runge-Kutta method.

15. Using technique of Monte Carlo method obtain the value of π correct to two decimal places .

16. Using Monte Carlo technique calculate the value of the given integral. Compare your result with result obtained by analytical method.

17. Write a program to solve the given system of linear equations by the Gauss elimination method.

18. Find out inverse of a given matrix by using Gauss-Jordan method.

19. Numerical solution of second-order differential equations using the fourth order Runge-Kutta method.

20. Fast Fourier Transform of a given signal.

21. Solution of Heat equation / Diffusion equation using Finite Difference Method.

22. A Duffing oscillator is given by $\ddot{x} + \delta \dot{x} + \beta x + \alpha\ ^3 = \gamma \cos \omega t$ where δ is damping constant>0. Write a program to study periodic and aperiodic behavior

23. Study of path of a Projectile in motion with and with out air drag and compare the values .

24. A study of Variation of magnetic field B(T) with critical temperature in superconductivity

25. Generation of output waveform of a Half wave / full wave rectifier.

26. Charging /discharging of a capacitor through an inductor and resistor

27. Variation in phase relation between applied voltage and current of a series L.C.R circuit

28. Phase plot of a pendulum (driven and damped pendulum)

29. Study variation of intensity along a screen due to the interference from Young's double slit experiment. Also study the variation of intensity with variation of distance of the screen from the slit.

30. Study variation of intensity along a screen due to the diffraction due to a grating

    .Also study the variation of intensity with variation of distance of the screen from the grating.

31. A particle obeying F-D statistics is constrained to be in 0 to 2eV at 300K. Calculate Fermi energy of this particle assuming kT =.025eV at 300K

32. Solve the differential equation and study periodic and aperiodic behaviour:
    $y' = \sigma(y-x)$, $y'=x(\mu-z)-y$, $y'=xy-\beta z$

33. Study the difference equation $X_{n+1} = mX_n\ (1 - X_n)$ and obtain periodic and aperiodic behavior.

34. Generate a standing wave pattern and study change in pattern by changing its various parameters.
35. Motion of a spherical body in a viscous medium

Reference books

1. Computational Physics: An Introduction, R.C. Verma, P.K. Ahluwalia & K.C. Sharma, New Age India, Pvt. Ltd ,2014.

2. An Introduction To Computational Physics, 2nd Edn,Tao Pang Cambridge University Press, 2010

3. Numerical Recipes: The Art of Scientific Computing 3rd Edn, William H. Press Cambridge University Press, 2007.

SEMESTER IV

20P4PHYT13: ATOMIC AND MOLECULAR PHYSICS

Total Credits: 4

Total Hours: 90

Course Outcomes

(i) To understand atomic structure and spectra of typical one- electron and two-electron systems.

(ii) To understand the theory of microwave and infra-red spectroscopies as well as the electronic spectroscopy of molecules;

(iii) To understand the basics of Raman spectroscopy and the nonlinear Raman effects;

(iv) To understand the spin resonance spectroscopies such as NMR and ESR.

UNIT 1

Atomic Spectra (18 Hrs)

1.1 The quantum mechanical treatment of hydrogen atom- quantum numbers n, l and m_l; spectra of alkali metal vapours 1.2 Derivation of spin-orbit interaction energy in hydrogen-like atoms; extension to penetrating orbits; fine structure in sodium atom 1.3 Normal Zeeman effect; Anomalous Zeeman effect- magnetic moment of the atom and g factor; spectral frequencies; Lande g-formula. 1.4 Paschen–Back effect – splitting of sodium D-lines ; Stark effect – quadratic Stark effect in potassium doublet. 1.5 L S coupling scheme -spectroscopic terms arising from two valence electrons; terms arising from two equivalent s-electrons; derivation of interaction energy - combination of s and p electrons; Hund's rule, Lande interval rule. 1.6 The jj coupling scheme in two electron systems -derivation of interaction energy- combination of s and p electrons ;Hyperfine structure .(qualitative ideas only).

UNIT II

Microwave and Infra Red Spectroscopy (18 Hrs)

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

2.3 Information derived from rotational spectra(molecular structure, dipole moment , atomic mass and nuclear quadrupole moment).2.4Vibrational energy of a diatomic molecule- simple harmonic oscillator –energy levels; diatomic molecule as anharmonic oscillator- energy levels; infrared selection rules; spectrum of a vibrating diatomic molecule. 2.5 Diatomic vibrating rotator –P and R branches; break down of Born-Oppenheimer approximation. 2.6 Vibrations of polyatomic molecules – fundamental vibrations and their symmetry; overtone and combination frequencies; Analysis by IR techniques- skeletal vibrations and group frequencies.

UNIT III

Raman Spectroscopy and Electronic Spectroscopy. (18 Hrs)

3.1Quantum theory of Raman effect**;** classical theory-molecular polarizability ;Pure rotational Raman spectra of linear molecules 3.2 Raman activity of vibrations; rule of mutual exclusion; vibrational Raman spectra ;rotational fine structure 3.3 Structure determination from Raman and IR spectroscopy. 3.4 Non- linear Raman effects - hyper Raman effect - classical treatment; stimulated Raman effect - CARS, PARS - inverse Raman effect. 3.5 Electronic spectra of diatomic molecules –Born-Oppenheimer approximation, vibrational coarse structure-progressions and sequences

; intensity of spectral lines- Franck – Condon principle 3.6 Dissociation energy and dissociation products; Rotational fine structure of electronic-vibrational transition ; Fortrat parabola; Predissociation.

UNIT IV

Spin Resonance Spectroscopy (18 Hrs)

4.1 Nuclear Magnetic Resonance (NMR)**-**resonance condition ; relaxation processes -Bloch equations 4.2 Chemical shift ; indirect spin–spin interaction4.3 CW NMR spectrometer; Magnetic Resonance Imaging.4.4 Electron Spin Resonance(ESR)-Principle of ESR; thermal equilibrium and relaxation; ESR spectrometer; characteristics of the g-factor. 4.5 Total Hamiltonian for an electron; Hyperfine Structure- ESR spectrum of hydrogen atom. 4.6 Mossbauer effect - recoilless emission and absorption; Experimental techniques in Mossbauer spectroscopy 4.7 Isomer shift; quadrupole interaction ; magnetic hyperfine interaction.

UNIT V

Advanced Spectroscopic Techniques (18 hrs)

5.1 Scanning Electron Microscopy (SEM) 5.2 Transmission Electron Microscopy (TEM), Environmental TEM, Scanning Transmission electron Microscopy (STEM), 5.3 In situ nano measurements, EELS 5.4 Electron Diffraction as Tool 5.5 Scanning Tunnelling Microscopy (STM) 5.6 Atomic Force Microscopy 5.7 Confocal Microscopy, Scanning near field optical microscopy (SNOM). 5.8 X-ray diffraction (XRD), Small angle X-ray scattering (SAXS)

Recommended Text Books:

1. Spectroscopy, B.P. Straughan& S. Walker, Vol. 1, John Wiley &Sons
2. Introduction of Atomic Spectra, H.E. White, Mc Graw Hill.
3. Fundamentals of molecular spectroscopy, C.N. Banwell and E M McCash, TataMcGraw Hill Education Private Limited.
4. Molecular structure and spectroscopy, G. Aruldhas, PHI LearningPvt. Ltd.
5. A textbook of nanoscience and nanotechnology, T. Pradeep, Tata McGraw-Hill Education

Recommended References:

1. Spectroscopy (Vol. 2 & 3), B.P. Straughan& S. Walker, Science
2. paperbacks 1976
3. Raman Spectroscopy, D.A. Long, Mc Graw Hill international, 1977
4. Introduction to Molecular Spectroscopy, G.M. Barrow, Mc Graw Hill
5. Introduction to Spectroscopy, D L Pavia, G M Lampman and G S Kriz, Thomson Learning Inc.
6. Modern Spectroscopy, J M Hollas, John Wiley .
7. Elements of Spectroscopy, Gupta, Kumar & Sharma, PragathiPrakshan.

8. https:// teaching.shu.ac.uk/hwb/chemistry/tutorials/molspec/nmr1.htm
9. https://ntpel.ac.in/courses/15101003/downloads/modu21/lecture23.pdf
10. https://www.ias.ac.in/article/fulltext/reso/009/0034-0049
11. https://ntpel.ac.in/courses/122101001/downloads/modu21/lec-15.pdf
12. https://www.youtube.com/watch?v=Q2Fo5BARe Go

20P4PHYT14: NUCLEAR AND PARTICLE PHYSICS

Total Credits: 4

Total Hours: 90

Course Outcomes

(i) Understand the basic properties of the nucleus and the nuclear forces.
(ii) Understand Major models of the nucleus and the theory behind the nuclear decay process
(iii) Understand the physics of nuclear reactions
(iv) Understand the interaction between elementary particles and the conservation

Unit I

Nuclear Properties and Force between Nucleons (18 Hrs)

1.1 The nuclear radius- distribution of nuclear charge (isotope shift, muonic shift, mirror nuclei); distribution of nuclear matter. Mass and abundance of nuclides, nuclear binding energy.

1.2 Nuclear angular momentum and parity ; Nuclear electromagnetic moments-quadrupole moment. 1.3 The deuteron-binding energy, spin, parity, magnetic moment and electric quadrupole moment. 1.4 Nucleon-nucleon scattering; proton-proton and neutron-nuetron interactions 1.5 Properties of nuclear forces 1.6 Exchange force model.

Unit II

Nuclear Models and Nuclear Decay (18 Hrs)

2.1 Liquid drop model, Bethe–Weizacker formula, Applications of semi- emperical binding energy formula. 2.2 Shell Model-Shell model potential, Spin-orbit potential, Magnetic dipole moments, Electric quadrupole moments, Valence Nucleons .2.3 Collective structure- Nuclear vibrations, Nuclear rotations.

2.4 Beta decay- energy release in beta decay ; Fermi theory of beta decay 2.5 Angular momentum and parity selection rules- allowed and forbidden transitions. Comparative half lives and forbidden decays; non-conservation of parity in beta decay 2.6 Gamma decay- angular momentum and parity selection rules ; internal conversion.

Unit III Nuclear Reactions (18Hrs)

3.1Types of reactions and conservation laws, energetics of nuclear reactions, isospin.

3.2 Reaction cross sections, Coulomb scattering- Rutherford formula, nuclear scattering. 3.3 Scattering and reaction cross sections in terms of partial wave amplitudes. 3.4 Compound-nucleus reactions; Direct reactions. 3.5 Resonance Reactions.

Unit IV

Particle Physics (18 Hrs)

4.1 Yukawa's hypothesis; properties of pi mesons- electric charge, isospin, mass, spin and parity. 4.2 Decay modes and production of pi-mesons 4.3 Types of interactions between elementary particles, Hadrons and leptons .4.4 Symmetries and conservation laws, C P and CPT invariance, applications of symmetry arguments to particle reactions, parity non-conservation in weak interactions.4.5 Quark model, confined quarks, coloured quarks and gluons, experimental evidences for quark model, quark-gluon interaction, quark dynamics.4.6 Grand unified theories, standard model of particle physics.

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

5.1 Particle and nuclear interactions in the early universe, primordial nucleosynthesis

5.2 Stellar nucleosynthesis (for both A<60 and A>60) 5.3 Higg's boson and the LHC experiments; detection of gravitational waves and LIGO (qualitative ideas only)

5.4 Rutherford Backscattering spectroscopy and applications 5.5 Computerized Axial Tomography (CAT) 5.6 Positron Emission Tomography (PET)

Recommended Text Books:

1. Introductory Nuclear Physics, K. S. Krane JohnWiley

2. Nuclear Physics, S.N. Ghoshal, S. Chand & Company.

3. Nuclear Physics: Problem-based Approach Including MATLAB, Hari M Agarwal, PHI Learning Private Limited, Delhi .

Recommended References:

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

ELECTIVE 3

20P4PHYT15: COMMUNICATION SYSTEMS

Total Credits: 3

Total Hours: 90

Course Outcomes

(i) To understand the basic concepts of different communication systems.

(ii) To understand the basic principles underlying radar and their applications

UNIT 1

Digital Communication(18 hrs)

1.1 Pulse Communication -Introduction - Pulse modulation :– PAM - PWM – PPM-

PCM 1.2 PCM:– Sampling theorem- Quantisation -Noise Generation and demodulation of PCM- Companding - DPCM- ADPCM-Delta modulation 1.3 Information theory-Coding-Noise-Data Communication – Digital codes – Error detection and correction 1.4 Data sets and interconnection requirements-Modem classification and interfacings1.5 Multiplexing techniques -Frequency division multiplex -Time division multiplex1.6 Digital transmission techniques:-ASK- FSK-PSK-QPSK.

UNIT II

Mobile communication(20 hrs)

2.1Introduction to Wireless Communication Systems-Mobile Radio System Around the World- Examples of wireless communication systems: - Paging system-Cordless Telephone System- Cellular Telephone System—How a Cellular Telephone Call is Made-Comparison of Common Mobile Radio Systems- Trends in Cellular and Personal Communications2.2 Wireless communication systems—2G-3G - 4G

2.3 The Cellular Concept-Frequency Reuse-Channel Assignment Strategies-Handoff Strategies:—Prioritizing handoffs and practical handoff consideration-Interference and System Capacity-Improving Coverage and Capacity in Cellular Systems:—Cell splitting-Sectoring-Microcell zone concept 2.4 Basic idea of Path Loss and Multipath Fading 2.5Multiple Access Techniques –Introduction-FDMA-TDMA-SSMA:- FHMA-CDMA-Hybrid Spread Spectrum Techniques-SDMA 2.6 GSM.

UNIT III
Satellite Communication (16 hrs)

3.1 Satellite Communication Fundamentals-Satellite Orbits-Satellite Positioning-Frequency Allocations-Polarization-Antennas—gain-beam width-Multiple Access Techniques 3.2 Geostationary Satellite communication-Satellite parameters 3.3VSAT (Basic Idea) 3.4Geostationary Satellite Path/Link Budget 3.5 Satellite TV Systems-Satellite TV broadcasting 3.6GPS.

UNIT IV

Fiber Optics Communication(20 hrs)

4.1 Introduction 4.2 Ray theory transmission-Total Internal Reflection-Acceptance Angle-Numerical aperture-Skew rays 4.3 Electromagnetic mode theory for optical propagation-Electromagnetic waves-Modes in a planar guide-Phase an group velocity 4.4 Fiber Classification-cylindrical fiber-Step Index- Graded Index-Single mode fiber:- Cut off wave length-Group delay -Photonic crystal fibers:-Index guided micro structures-Photonic band gapfibers 4.5 Dispersion:- chromatic-intermodal-Non linear effects 4.6 Optical fiber connection-Fiber Splices:-Fusion splices- Mechanical splices-Multiple splices-Fiber connectors:- Cylindrical ferrule connectors, Duplex and multiple-fiber connectors-Fiber couplers(basic idea).

UNIT V

Radar Systems (16 hrs)

5.1 Basic Principles –Fundamentals:- Basic radar Systems-Development of Radar-Radar Performance Factors:—Radar range equation-factors influencing maximum range-Effects of noise- Target properties 5.2 Pulsed Systems-Block diagram and description-Antennas and Scanning:-Antennas Scanning- Antenna tracking-Display Methods5.3 Pulsed radar systems-Moving Target Indication:- Doppler Effect-Fundamentals of MTI-Delay Line- Blind speeds-Radar Beacons5.4Other radar systems-CW Doppler Radar-Frequency Modulated CW Radar-Phased ArrayRadars-Planar Array Radars.

Recommended Text Books:

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

4. Optical fiber communications-Principles and Practice John M Senior, Pearson publications, 3rd edition, (Module-4).

Recommended References:

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

20P4PHYP04: ADVANCED ELECTRONICS PRACTICALS

Total credit: 4

Total hours: 180

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

[A] Microprocessors and Micro Controllers (use a PC or 8086-μp kit)

1. Sorting of numbers in ascending/descending order.
2. Find the largest and smallest of numbers in array of memory.
3. Conversion of Hexadecimal number to ASCII and ASCII to Hexadecimal number.
4. Multi channel analog voltage measurements using AC card.
5. Generation of square wave of different periods using a microcontroller.
6. Measurement of frequency, current and voltage using microprocessors.
7. Stepper motor control using 8086 microprocessor

[B] Communication Electronics

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

[C] Electronic Instrumentation

13. DC and AC milli-voltmeter construction and calibration.
14. Amplified DC voltmeter using FET.
15. Instrumentation amplifier using a transducer.
16. Generation of BH curve and diode characteristics on CRO.
17. Voltage to frequency and frequency to voltage conversion.

18. Construction of digital frequency meter.
19. Characterization of PLL and frequency multiplier and FM detector.

[D] Optoelectronics

20. Characteristic of a photo diode - Determination of the relevant parameters.
21. Beam Profile of laser, spot size and divergence.
22. Temperature co-efficient of resistance of copper.
23. Data transmission and reception through optical fiber link.
24. Faraday Effect – Verdet constant
25. Pockel effect – Half wave voltage, extinction ratio and birefringence of the given crystal.
26. Spectral Characterization of LED
27. Optical fibre characterization – Numerical aperture
28. Phototransistor, photodiode and opto coupler characteristics.
29. Solar cell characteristics.
30. Optical beat note experiment.

References

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