SACRED HEART COLLEGE (AUTONOMOUS), THEVARA

KOCHI, KERALA, 682013

CURRICULUM AND SYLLABUS

FOR

M.Sc. PHYSICS

CHOICE BASED CREDIT AND SEMESTER SYSTEM (CBCSS)

INTRODUCED FROM 2024 ADMISSIONS ONWARDS

Prepared by:
BOARD OF STUDIES IN PHYSICS

Sacred Heart College, Thevara, Kochi, Kerala

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SACRED HEART COLLEGE (AUTONOMOUS), THEVARA, KOCHI, KERALA

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CONTENTS

1. INTRODUCTION

The scientific thinking in context of Physics has gained significant attraction in recent years, particularly in tandem with the evolution of new branches of science such as Nanotechnology, Data science, Robotics and Artificial intelligence. The fundamental understanding, albeit remains as one of the key elements to be inculcated in the curriculum, the exposure and training in the advanced fields of Science has a greater role in the overall development as well as shaping a proper roadmap to a Physics student. MSc. Physics forms the final formal training of Physics and hence the program aims at providing an in depth knowledge of Physics to the student. After the successful completion of the program, a student should be capable of pursuing research in theoretical/ experimental physics or related areas. The student is expected to acquire a thorough understanding of the fundamentals of Physics so as to select an academic career in secondary or tertiary level. The program also aims at enhancing the employability of the student. Rigorous training requires phased teaching. With this intention credit and semester system is followed in this program. An M.Sc student should be capable of doing research at least in the preliminary way. To accomplish this, research oriented project is made part of this curriculum.

The creation of a scientific thinking and scientific attitude necessitates proper education and guidance. In order to achieve this, one must update the developments in every field of science. An effective science education can be imparted at the postgraduate level only by constantly updating the existing curriculum. The present postgraduate curriculum in Physics was revised in 2016 after the college was elevated to 'Autonomous' status in 2014. The Board of Studies in Physics then revised the curriculum in tune with the parent University and the University Grants Commission's model for Postgraduate Curriculum. In this process, care has been taken to give emphasis to various aspects such as the creativity of students, knowledge of current developments in the discipline, the skills essential for handling equipment and instruments in laboratories and industries, developing research aptitude, employability and entrepreneur development. Care has also been taken to introduce into the curriculum, student centric learning methods such as experiential learning, participative learning and problem-solving methodologies.

The Board of Studies in Physics recommended the revision of the existing PG Physics Syllabus in comparison with the parent university (MG University) syllabus with appropriate modifications. The Academic Council of the college decided to implement the revised syllabus with effect from the academic year 2021-22.

Programme Outcomes

At the end of the programme, the students will

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

PSO1: Postgraduates will develop the critical analysis and problem-solving skills required in the application of principles of Physics.

PSO2: Postgraduates will be prepared with a working knowledge of experimental/computational techniques and instrumentation required to work independently in research or industrial environments.

PSO3: Postgraduates will have strong capability in organizing and presenting the acquired knowledge both in oral and written platforms.

PSO4: Postgraduates will successfully compete for current employment opportunities.

Eligibility for Admission

Graduation in Physics or Electronic Equipment maintenance with not less than 50% marks or equivalent grade in the Part III subjects (Main/Core + subsidiaries/Complementariness)

2. REGULATIONS FOR POST GRADUATE PROGRAMMES UNDER CREDIT SEMESTER SYSTEM (CSS)– 2024

2.1 TITLE

These regulations shall be called 'SACRED HEART COLLEGE REGULATIONS FOR POST GRADUATE PROGRAMMES UNDER CREDIT SEMESTER SYSTEM (CSS) – 2024

2.2 SCOPE

Applicable to all Post Graduate (PG) programmes of the college with effect from 2024 admissions. The provisions herein supersede all the existing regulations for the post graduate programmes of the college.

2.3 DEFINITIONS

2.3.1 '**Programme**' means the entire course of study and examinations.

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

2.3.3 **'Semester'** means a term consisting of a minimum of ninety working days, inclusive of examination, distributed over a minimum of eighteen weeks each having five working days, each with five contact hours of one hour duration.

2.3.4 **'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/ study tour /seminar / project / practical training / assignments/evaluation etc., to meet effective teaching and learning requirements.

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

2.3.6 '**Extra credits**' are additional credits awarded to a student over and above the minimum credits required for a programme.

2.3.7 '**Programme Credit'** means the total credits of the PG Programmes. For PG programmes the total credits shall be eighty.

2.3.8 **'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.

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

2.3.10 '**Programme Project'** means a regular project work with stated credits on which the student undergoes 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.

2.3.11 ‘**Internship**’ is on-the-job training for professional careers.

2.3.12 ‘**Plagiarism**’ is the unreferenced use of other authors’ material in dissertations and is a serious academic offence.

2.3.13 ‘**Seminar‘** means a lecture by a student, expected to train the student in self-study, collection of relevant matter from the books and internet resources, editing, document writing, typing and presentation.

2.3.14 **‘Evaluation’** is the process by which the knowledge acquired by the students is quantified as per the criteria detailed in the regulations.

2.3.15 **‘Repeat Course’** is a course that is repeated by a student for having failed in that course in an earlier registration.

2.3.16 **‘Audit Course’** is a course for which no credits are awarded.

2.3.17 **‘Department’** means any teaching department offering a programme of study approved by the college / institute as per the Act or Statute of the University.

2.3.18 **‘Department Council’** means the body of all teachers of a department in a college.

2.3.19 **‘Faculty Advisor’** is a teacher nominated by a Department Council to coordinate the continuous evaluation and other academic activities undertaken in the department.

2.3.20 **‘College Coordinator’** means a teacher from the college nominated by the College Council to look into the matters relating to CSS-PG system.

2.3.21 **‘Letter Grade’** or simply **‘Grade’** in a course is a letter symbol (A^+, A, B^+, B etc.) which indicates the broad level of performance of a student in a course.

2.3.22 **‘Grade Point’** (GP), is an integer indicating the numerical equivalent of the broad level of performance of a student in a course.

2.3.23 **‘Grade Point Average’ (GPA)** is an index of the performance of a student in a course. It is obtained by dividing the sum of the weighted grade points obtained in the course by the sum of the weights of the course ($GPA = \sum WGP/\sum W$).

2.3.24 **‘Weighted Grade Point’ (WGP)** is obtained by multiplying the grade point by its weight (WGP = GP x weight).

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

2.3.26 **‘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 of the courses taken by him/her in that semester. The SGPA shall be rounded off to two decimal places and it determines the overall performance of a student at the end of a semester.

2.3.27 '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.

2.3.28 'Grace Grade Points' means grade points awarded to a student for course(s), in recognition of meritorious achievements in NSS/Sports/Arts and cultural activities, as per the orders issued by the college from time to time.

2.4 ATTENDANCE

Being a regular college, physical presence in the regular activities, especially, classes and exams, is mandatory for the students. However, if a student secures 75% of attendance he/she is eligible to appear for the exams, provided there are no other impediments like disciplinary proceedings, malpractice record etc.

2.4.1 Absence: A student found absent for one hour in the forenoon or afternoon session is deprived of the attendance for the entire session as far as eligibility for final exam is concerned.

2.4.2 Leave: A student has to formally report his/her absence with reasons either in advance, or immediately after the absence for obtaining an approved leave. This applies to all sorts of leave – medical, on duty or similar cases.

2.4.3 The student has to retain a copy/section of the approved leave form and produce the same as proof, in case there is any confusion regarding the leave sanctioning. In the absence of such proof, the claims will not be entertained.

2.4.4 Duty Leave: A student representing the college in sports, arts, social service or academic matters, has to get sanction from the class teacher concerned and submit the leave application form duly endorsed by the class teacher and the Head of the Department, and submit it to the Vice Principal. The same will be forwarded by the Vice Principal for attendance entry. The approval of the Department of Physical Education and the class teacher is required for granting attendance related to sports. The time limit for submission mentioned above is applicable in the case of duty leave as well.

2.4.5 Condonation: A student may have the privilege of condonation of attendance shortage (up to a maximum of ten days) on the basis of genuineness of the grounds of absence (medical reasons or college duty), duly recommended by the department. This is not a matter of right. It is a matter of privilege based on Principal's discretion and the good conduct of the student on the campus. A student of PG programme may have only one such opportunity.

2.4.6 Re-admission: A student whose attendance is inadequate will have to discontinue the studies. Such students, whose conduct is good, may be re-admitted with the approval of Governing Body, on the basis of recommendation from the department, and assurance from the student and the guardian regarding good conduct and compliance in academic and discipline matters. For this the prescribed re-admission fee has to be paid.

2.4.7 Unauthorized absence & removal from rolls: A student, absent from the classes continuously for ten consecutive working days without due intimation or permission, shall be removed from the rolls, and the matter shall be intimated to the student concerned. On the basis of recommendation of the department concerned, re-admission process may be permitted by the Principal.

2.5 PROGRAMME REGISTRATION

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

2.5.2 A PG student who registered for the programme shall complete the same within a period of eight continuous semesters from the date of commencement of the programme.

2.6 PROMOTION

A student who registers for the end semester examination shall be promoted to the next semester. However, in extreme circumstances, a student having sufficient attendance who could not register for the end semester examination may be allowed to register notionally by the Principal with the recommendation of the Head of the Department concerned andby paying the prescribed fee.

2.7 EXAMINATIONS

All the end semester examinations of the college will be conducted by the Controller of Examinations. The Principal will be the Chief Controller of Examinations. An Examination Committee consisting of the Chief Controller of Examinations, Controller of Examinations, Additional Chief Superintendent, Deans, IQAC Coordinator and other faculty members nominated by the Principal will act as an advisory body on the matters relating to the conduct of examinations.

2.8 EVALUATION AND GRADING

2.8.1 Evaluation

The evaluation scheme for each course shall contain two parts:

a. **Continuous Internal Assessment (CIA)**
b. **End Semester Examination (ESE)**

25% weightage shall be given to internal evaluation and the remaining 75% to external evaluation and the ratio and weightage between internal and external is **1:3**, for the courses with or without practicals (except the courses offered by the School of Communications). In the case of courses offered by the School of Communications, the internal-external assessment ratio shall be **1:1**. In their case, the components for evaluation and their respective weightage shall be determined by their Board of Studies. Both internal and external evaluation shall be carried out in the grading system and the GPAs are to be rounded to two places of decimal.

2.8.2 **Direct Grading:** The direct grading for the components of CIA shall be based on six letter grades (A+, A, B, C, D and E) with numerical values of 5, 4, 3, 2, 1 and 0 respectively as per the following scale of accuracy/level of quality. The questions for internal test papers and the end semester examination shall be prepared in such a way that the answers can be awarded A+, A, B, C, D and E grades.

Grade	Grade Points	Scale of accuracy/Level of quality
A+	5	Greater than or equal to 90%
A	4	80% to less than 90%
B	3	60% to less than 80%
C	2	40% to less than 60%
D	1	20% to less than 40%
E	0	Less than 20%

2.8.3 Grade Point Average (GPA): Internal and external components are separately graded and the combined GPA shall be calculated for each course with weightage **1** for internal and **3** for external.

2.8.4 Components of Continuous Internal Assessment (CIA): Grades shall be given to the evaluation of theory/practical/project/comprehensive viva-voce and all internal evaluations are based on the Direct Grading System.

The Board of studies of the respective subject is permitted to make changes, if necessary, with regard to the weightages for the components of CIA without changing the total weightage of 5.

a. Components of Internal Evaluation (for theory)

Sl.No	Components	Weightage
i.	Assignments	1
ii.	Seminar	1
iii.	Quiz/Field study/Industrial Visit/Viva Voce/Study Tour	1
iv.	Test paper-1	1
v.	Test paper-2	1
	Total	5

b. **Components of Internal Evaluation (for practical)**

Components	Weightage
Laboratory Involvement	1
Written/ Lab Test	2

Record	1
Viva Voce	1
Total	5

c. Components of Internal Evaluation (for project)

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

d. Components of Internal Evaluation(for comprehensive viva voce)

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

2.8.5 Components of End Semester Examination (ESE):

a. **For Theory**

Evaluation shall be based on the following pattern of questions:

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

*Board of studies of respective subjects can decide on the number questions in each of type of questions.

b. **For Practical**

Components of External Evaluation (for practical)

Components	Weightage
Laboratory Involvement	3
Written/ Lab Test	6

Record	3
Viva Voce	3
Total	15

The Board of studies of the respective subject is permitted to make changes, if necessary, with regard to the weightages for the components of Practical Examinations (External) without changing the total weightage i.e. 15. The pattern of questions for external evaluation of practical examinations can also be prescribed by the respective Board of Studies.

c. **Components of External Evaluation (for project)**

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

d. **Components of External Evaluation(for comprehensive viva voce)**

Components	Weightage
Seminar Presentation	5
Topic from selected paper	2
Other M.Sc. topics	5
Basic Physics (Class 12, UG)	3
Total	15

2.8.6 Project:

Project work is a part of the syllabus of most of the programmes offered by the college. The guidelines for doing projects are as follows:

i. Project work shall be completed by working outside the regular teaching hours.
ii. Project work shall be carried out under the supervision of a teacher in the concerned department or an external supervisor.
iii. 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.
iv. There should be an internal assessment and external assessment for the project work in

the ratio 1:3

v. The external evaluation of the project work consists of valuation of the dissertation (project report) followed by presentation of the work and viva voce.

2.9 PERFORMANCE GRADING

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

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

2.9.2 No**separate minimum** is required for internal evaluation for a pass, but a minimum a '**C**' grade is required for a pass in an external examination. However, a minimum '**C**' grade is required for pass in a course and the programme as well.

2.9.3 A student who fails to secure a minimum grade '**C**' for a pass in a course shall be permitted to write the examination along with the next batch.

2.9.4 Improvement of GPA: The candidates who wish to improve the GPA of the external examinations of a course/courses can do the same by appearing in the external examination of the semester concerned along with the immediate junior batch. The facility is restricted to first and second semesters of the programme.

2.9.5 Computation of SGPA and CGPA: For the successful completion of a semester, a student should pass all the courses and score at least the minimum SGPA grade **'C'**. After the successful completion of a semester, Semester Grade Point Average (**SGPA**) of a student in that semester is calculated as the ratio of the sum of the credit points of all courses taken by a student in the semester to the total credits of that semester.

Thus, **SGPA = TCP/TCr**, where **TCP** is **Total Credit Point of that semester (** $\sum_{i=1}^{n} CP_i$ **)** and**TCr is Total Credit of that semester (** $\sum_{i=1}^{n} Cr_i$ **)** where '**n**' is the number of courses in that semester.

Cumulative Grade Point Average (**CGPA**) of a programme is calculated as the ratio of the sum of the credit points of all the courses of the programme to the total credits of the programme.

$$CGPA = \frac{\sum (SGPA \times TCr)}{\sum TCr}$$

The SGPA/CGPA shall be rounded off to two decimal places.

For the successful completion of a programme, a student should pass all the courses and score at least the minimum CGPA grade **'C'**. However, a student is permitted to move to the next semester irrespective of her/his SGPA.

To ensure transparency of the evaluation process, the internal assessment grade awarded to the students in each course in a semester shall be published on the notice board/website at least one week before the commencement of external examination. There shall not be any chance for improvement for internal assessment grade.

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 Head of the Department and a copy should be kept in the department for at least two years for verification.

2.10 REGISTRATION FOR THE EXAMINATION

a. All students admitted in a programme with remittance of prescribed fee are eligible for the forthcoming semester examinations.
b. Online application for registration to the various End Semester Examinations shall be forwarded to the CE along with prescribed fee for each course in prescribed format.
c. The eligible candidates who secure the prescribed minimum attendance of the total duration of the course and possess other minimum qualification prescribed in the regulations for each course shall be issued the hall tickets. The hall ticket shall be downloaded by the students from the college website.

The mode of fee remittance shall be through the prescribed bank.

2.11 SUPPLEMENTARY EXAMINATIONS

Candidates who failed in an examination can write the supplementary examination conducted by the College along with regular examinations.

2.12 PROMOTION TO THE NEXT HIGHER SEMESTER

A candidate shall be eligible for promotion from one semester to the next higher semester if,

a. He / she secures a minimum 75 % attendance and registered for the End Semester Examination of the programme for which he/she is studying.
b. His / her progress of study and conduct are satisfactory during the semester completed, as per the assessments recorded by the course teachers and the Head of the Department concerned.

2.13 CERTIFICATES

1. Diploma and Degree certificates are issued by the Mahatma Gandhi University, Kottayam as per the act and statues of the University on the submission of the consolidated mark / score cards of the students by the College.
2. A consolidated mark / scored card shall be issued to the candidates after the publication of the results of the final semester examination taken by the candidate.
3. A Course Completion Certificate with classification shall be issued to students till the provisional certificate is issued by the university.

2.14 RANK CERTIFICATE

Candidates shall be ranked in the order of merit based on the CGPA secured by them. Grace grade points awarded to the students shall not be counted for fixing the rank/positions. Rank certificates shall be issued to the candidates who secure positions from the first to the third in the order of merit. The position certificates shall be issued to the next seven candidates in the order of merit.

2.15 AWARD OF DEGREE

The successful completion of all the courses with **'C'** grade shall be the minimum requirement for the award of the degree.

2.16 MONITORING

There shall be a Monitoring Committee constituted by the Principal consisting of faculty advisors, HoD, a member from Teaching Learning Evaluation Committee (TLE) and the Deans to monitor the internal evaluations conducted by college. The course teacher, class teacher and the deans should keep all the records of the internal evaluation, for at least a period of two years, for verification.

Every programme conducted under Credit Semester System shall be monitored by the College Council under the guidance of IQAC Coordinator, Controller of Exams, Academic Deans and HoDs. An academic committee consisting of the vice principal, deans and teachers nominated by the Principal shall look after the day-to-day affairs of these regulations.

2.17 GRIEVANCE 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: Level of the course teacher concerned

Level 2: 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 Faculty concerned, HOD of the department concerned and one member of the Academic Council nominated by the Principal every year as members

2.18 TRANSITORY PROVISION

Notwithstanding anything contained in these regulations, the Principal of the college has the power to make changes in these regulations, by due orders, that shall be applied to any programme with such modifications as may be necessary on the recommendations of the Board of Studies of the respective programme.

3. PROGRAMME STRUCTURE

Semester	Course Code	Name of the courses	No of hrs / week	Credits
I	24P1PHYT01	Mathematical methods in Physics – I	3	3
	24P1PHYT02	Classical Mechanics	4	4
	24P1PHYT03	Electrodynamics	4	4
	24P1PHYT04	Electronics	4	4
	24P1PHYP02	General Physics Practicals*	6	
	24P2PHYP02	Electronics Practicals*	4	
		Total for Semester 1	**25**	**15**
II	24P2PHYT05	Mathematical methods in Physics – II	4	4
	24P2PHYT06	Quantum Mechanics – I	3	4
	24P2PHYT07	Condensed Matter Physics	4	4
	24P2PHYT08	Thermodynamics and Statistical Mechanics	4	4
	24P2PHYP01	General Physics Practicals	4	3
	24P2PHYP02	Electronics Practicals	6	3
		Total for Semester 2	**25**	**22**
III	24P3PHYT09	Quantum Mechanics – II	4	4
	24P3PHYT10	Computational Physics	4	4
	24P3PHYT11EL	Micro Electronics and Semiconductor Devices [Elective 1]	4	4
	24P3PHYT12EL	Digital Signal Processing [Elective 2]	3	3
	24P4PHYP03	Computational Physics Practicals*	6	
	24P4PHYP04	Advanced Electronics Practicals*	4	
		Total for Semester 3	**25**	**15**
IV	24P4PHYT13	Atomic and Molecular Physics	4	4
	24P4PHYT14	Nuclear and Particle Physics	4	4
	24P4PHYT15EL	Communication Systems [Elective 3]	3	3
	24P4PHYT16EL	Optoelectronics [Elective 4]	4	4
	24P4PHYP03	Computational Physics Practicals	4	3
	24P4PHYP04	Advanced Electronics Practicals	6	3
	24P4PHYPT	Project	-	5
	24P4PHYCV	Comprehensive viva voce	-	2
		Total for Semester 4	**25**	**28**
		Grand Total		**80**

Note: * Odd Semester Lab exams will be held along with the upcoming Even semester Lab exam.

4. 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 and Elective 4 will be dealt in semester IV.

1. COURSES

SEMESTER I

24P1PHYT01: MATHEMATICAL METHODS IN PHYSICS – I

Total Credits: 3 Total Hours: 54

Course Outcomes

i. Understand the basic theory of Vector analysis and to apply it to various Theorems
ii. Transformation of co-ordinates systems
iii. Understand the principals linear vector space
iv. Apply Probability concepts and remember distribution theory's
v. Analyze various Matrices
vi. Understand and apply tensor calculus to various physicals situation

UNIT I

Vector analysis (8 hrs)

1.1 Line, Surface and Volume integrals

1.2 Gradient, divergence and curl of vector Functions

1.3Gauss Divergence Theorem

1.4 Stoke's Theorem

1.5Green's Theorem

1.6 Potential Theory

1.6.1 Scalar Potential-Gravitational Potential, Centrifugal Potential

Curvilinear co-ordinates(8 hrs)

1.7 Transformation of co-ordinates

1.8 Orthogonal Curvilinear co-ordinates

1.9Unit Vectors in curvilinear systems

1.10Arc Length and Volume Elements

1.11Gradient, Divergence and Curl in orthogonal curvilinear co-ordinates

1.12 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)

2.1 Definition of linear vector space

2.2 Inner product of vectors

2.3 basis sets

2.4 Gram schmidt ortho normalization

2.5 Expansion of an arbitrary vector

2.6Schwarz inequality

Probability theory and distribution (6 hrs)

2.7 Elementary Probability Theory

2.8 Binomial Distribution

2.9 Poisson distribution

2.10 Gaussian Distribution

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 4.10Geodesics

Recommended 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

24P1PHYT02: 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 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.

24P1PHYT03: 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 waves

4.2.2 Rectangular waveguide- TE-TM waves -impossibility of TEM wave.

4.2.3 Cylindrical waveguide- TE-TM waves

Recommended books:

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.

24P1PHYT04: 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 filter
3.4 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.
4.7. Detection and automatic gain control – communication receiver.
4.8. FM receiver – phase discriminators – ratio detector – stereo FM reception

Recommended Books:

1. Op-amps and linear integrated circuits R.A. Gayakwad 4^{th}Edn.PHI
2. Electronic Communication Systems, Kennedy& Davis 4^{th}Ed.TMH,

Recommended References:

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

24P2PHYP01: GENERAL PHYSICS PRACTICALS

Total credits: 3

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.

19. Zeeman effect setup – measurement of Bohr magnetron
20. Michelson Interferometer – λ or thickness of mica.
21. Michelson Interferometer – refractive index of transparent material.
22. Michelson Interferometer – spatial and temporal coherence of laser.
23. Michelson Interferometer – Δλ of D1 and D2 lines of Sodium light.
24. Measurement of wave length of He-Ne laser light using ruler.
25. Half Shade Polari meter and Strain Viewer
26. GM counter – counting statistics/ absorption crossection/ half-life of a radioactive material
27. Clausius – Clapeyron : Determination of specific enthalpy
28. Hydrogen Spectrum – Determination of Rydberg constant
29. Specific rotation of Sugar solution.
30. Refractive index of a liquid (or transparent solid) using laser and Grating.
31. e/m of an electron by JJ Thomson experiment.
32. Millikan's oil drop experiment – determination of electronic charge
33. Photo electric effect - determination of planks constant.
34. Frank-Hertz Experiment.
35. Determination of diamagnetic and paramagnetic susceptibility of glass or water
36. ESR experiment determination of g factor.
37. Determination of ferromagnetic Curie temperature.
38. Magnetic Susceptibility - Gouy's method

References

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

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

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

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

5. Practical Physics, Gupta, Kumar, PragatiPrakasan.

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

24P2PHYP02: ELECTRONICS PRACTICAL

Total credit: 3

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:

1. Op-Amp and linear integrated circuit

Ramakanth A Gaykwad, Eastern Economy Edition, ISBN-81-203-0807-7

2. Electronic Laboratory Primer a design approach

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

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

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

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

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

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

SEMESTER II

24P2PHYT05: 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 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

24P2PHYT06: 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 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/

24P2PHYT07: 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 I

Elements of Crystal Structure (6 Hrs)

Review of crystal lattice fundamentals and interpretation of Bragg's equation, Ewald construction, the reciprocal lattice, reciprocal lattice to SC, BCC and FCC lattices, properties of reciprocal lattice, diffraction intensity - atomic, geometrical and crystal structure factors- physical significance.

Text Book:

1. Solid State Physics: Structure and properties of materials, M.A. Wahab, Narosa 2nd Edn. 2010, (Chapter 8**)**

Free Electron Theory of Metals (12 Hrs)

Review of Drude-Lorentz model - electrons moving in a one dimensional potential well - three dimensional well - quantum state and degeneracy - density of states - Fermi-Dirac statistics - effect of temperature on Fermi-Dirac distribution - electronic specific heat - electrical conductivity of metals - relaxation time and mean free path - electrical conductivity and Ohm's law - Widemann-Franz-Lorentz law - electrical resistivity of metals.

Text Book:

1. Solid State Physics: Structure and properties of materials, M.A. Wahab, Narosa 2nd Edn. 2010, (Chapter 10**)**

Unit II

Band Theory of Metals (6 Hrs)

Bloch theorem - Kronig-Penney model - Brillouin zone construction of Brillouin zone in one and two dimensions – extended, reduced and periodic zone scheme of Brillouin zone (qualitative idea only) - effective mass of electron - nearly free electron model – conductors - semiconductors - insulators.

Text Book:

1. Solid State Physics: Structure and properties of materials, M.A. Wahab, Narosa 2nd Edn. 2010, (Chapter 11**)**

Band theory of semiconductors (10 Hrs)

Generation and recombination - minority carrier life-time - mobility of current carriers - drift and diffusion - general study of excess carrier movement- diffusion length.

Text Book:

1. Solid State Physics, S.O. Pillai, New Age International 6th Edn. 2010, (Chapter 10).

Free carrier concentration in semiconductors - Fermi level and carrier concentration in semiconductors - mobility of charge carriers - effect of temperature on mobility - electrical conductivity of semiconductors - Hall Effect in semiconductors.

Ref. Text:

1. Solid State Physics: Structure and properties of materials, M.A. Wahab, Narosa 2nd Edn. 2010, (Chapter 13**)**

Unit III

Lattice Dynamics (14 Hrs)

Vibrations of crystals with monatomic basis – diatomic lattice – quantization of elastic waves – phonon momentum.

Text Book:

1. Introduction to Solid State Physics, C. Kittel, 3rd Edn. Wiley India. (Chapter 4).

Anharmonicity and thermal expansion - specific heat of a solid - classical model - Einstein model - density of states - Debye model - thermal conductivity of solids - thermal conductivity due to electrons and phonons - thermal resistance of solids.

Text Book:

1. Solid State Physics: Structure and properties of materials, M.A. Wahab, Narosa 2nd Edn. 2010, (Chapter 7 &9**)**

Dielectric Properties of Solids (6 Hrs)

Review of basic terms and relations, ferroelectricity, hysteresis, dipole theory - Curie-Weiss law, classification of ferroelectric materials and piezoelectricity.

Text Book:
1. Solid State Physics, S.O. Pillai, New Age International 6th Edn. 2010, (Chapter 11).

Ferroelectric domain, antiferroelectricity and ferrielectricity.

Text Book:

1. Solid State Physics: Structure and properties of materials, M.A. Wahab, Narosa 2nd Edn. 2010, (Chapter 14**)**

Unit IV

Magnetic properties of solids (10 hrs)

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

Text Book:

1. Solid State Physics, S.O. Pillai, New Age International 6th Edn. 2010, (Chapter 9).

Superconductivity (4 Hrs)

Thermodynamics and electrodynamics of superconductors- BCS theory- flux quantization-single particle tunneling- Josephson superconductor tunneling-macroscopic quantum interference

Text Book:

1. Introduction to Solid State Physics, C. Kittel, 3rd Edn. Wiley India. (Chapter 12).
2. Solid State Physics, S.O. Pillai, New Age International 6th Edn. 2010, (Chapter 8).

Nanotechnology and Metamaterials (Qualitative) (4 Hrs)

Properties of metal, semiconductor, rare gas and molecular nanoclusters-superconducting fullerene- quantum confined materials-quantum wells, wires, dots and rings- metamaterials-graphene

Text Book:

1. Introduction to Nanotechnology, Charles P Poole and Frank J Owens, Wiley India (Chapter 4, 5, 9)

Reference Books:

1. Solid State Physics, N.W. Ashcroft & N.D. Mermin, Cengage Learning Pub.11th Indian Reprint (2011).
2. Solid State Physics, R.L. Singhal, Kedar Nath Ram Nath & Co (1981)
3. Elementary Solid State Physics, M. Ali Omar, Pearson, 4th Indian Reprint (2004).
4. Solid State Physics, C.M. Kachhava, Tata McGraw-Hill (1990).
5. Elements of Solid State Physics, J. P. Srivastava, PHI (2004)
6. Solid State Physics, Dan Wei, Cengage Learning (2008)
7. Solid State Physics, A.J. Dekker, Macmillan & Co Ltd. (1967)

24P2PHYT08: THERMODYNAMICS AND STATISTICAL MECHANICS

Credits: 4 Total Lecture Hours: 72

Course Outcomes:

CO1: Explore the fundamental principles of thermodynamics and engage in discussions about their applications.

CO2: Utilize probability theory and quantum mechanics to analyze and calculate partition functions and other thermodynamic parameters for specific systems.

CO3: Gain an understanding of the statistical methods used in the study of blackbody radiation, as well as the models proposed by Einstein and Debye for describing vibrations in solid materials.

CO4: Develop a comprehensive understanding of the thermodynamic properties and behavior of Fermi gases and non-interacting Bose gas systems.

CO5: Differentiate between first-order phase transitions and continuous phase transitions, including their characteristics and significance in thermodynamics.

Module I:

Fundamental of Thermodynamics (10 Hrs)

First law of Thermodynamics - Fundamental definitions – different aspects of equilibrium – functions of state – internal energy – reversible changes – enthalpy – heat capacities – reversible

Adiabatic changes in an ideal gas. Second law of thermodynamics– the Carnot cycle - equivalence of the absolute and the perfect gas scale of temperature – definition of entropy measuring the entropy – law of increase of entropy – calculations of the increase in the entropy in irreversible processes – the approach to equilibrium.

Foundations of Statistical Mechanics (8 Hrs)

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

Module II:

The Canonical Ensemble (12 Hrs)

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

Statistics of Identical Particles (4 Hrs)

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

Module III:

Maxwell Distribution and Planck's Distribution (12 Hrs)

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

Grand Canonical Ensemble (8 Hrs)

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

Module IV:

Fermi and Bose Particles (6 Hrs)

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

Phase Transitions (12 Hrs)

Phases – thermodynamic potential – approximation – first order phase transition - Clapeyron equation – phase separation – phase separation in mixtures. Ising model – order parameter – Landau theory- symmetry breaking field – critical exponents

Recommended Books:

1. Introductory Statistical Mechanics, R. Bowley & M.Sanchez, 2ndEdn. 2007, Oxford University Press.

Recommended Reference Books:

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

SEMESTER III

24P3PHYT09: 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 understand the idea of Born approximation and the method of partial waves and resonances in scattering.

(v) Understand the basics 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 The WKB method and its validity; The WKB wave function in the classical region; non-classical region

1.5 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 and Scattering Theory (18hrs)

3.1 Bosons and fermions; anti-symmetric wave functions and Pauli's exclusion principle.

3.2 The Asymptotic wave function - differential scattering cross section and scattering amplitude

3.3 The Born approximation-scattering amplitude in Born approximation

3.4 validity of the Born approximation; Yukawa potential, Rutherford scattering.

3.5 The partial wave expansion, hard sphere scattering, S-wave scattering for the finite potential well,

3.6 resonances – Ramsaur - Townsend effect

UNIT IV

Relativistic Quantum Mechanics (18 hrs)

4.1 Need for relativistic wave equation.

4.2 Klein-Gordon equation - Probability conservation - covariant notation

4.3 Derivation of Dirac equation - conserved current representation - large and small components

4.4 Approximate Hamiltonian for electrostatic problem

4.5 free particle at rest -plane wave solutions - gamma matrices

4.6 relativistic covariance of Dirac equation

4.7 Angular momentum as constant of motion.

Recommended Text Books:

1.A modern Approach to Quantum Mechanics: John Townsend, Viva Books New Delhi (Unit-I) and (Unit –III)

2.Introduction to Quantum Mechanics: D.J. Griffith, Pearson Education (Unit-I)

3.Modern Quantum Mechanics: J. J. Sakurai, Pearson Education. (Unit-II)

4.Advanced Quantum Mechanics, J.J. Sakurai, Pearson Education (Unit-IV)

Recommended References:

1. Quantum Mechanics: 500 Problems with Solutions: G Aruldhas, Prentice Hall of India.
2. Problems and Solutions in Quantum Mechanics: Kyriakos Tamvakis, Cambridge University Press.
3. Introductory Quantum Mechanics: Richard L Liboff, Pearson Education.
4. Quantum Mechanics: V. K. Thankappan, New Age International.
5. 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

24P3PHYT10: 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.

3.7 Numerical Solution of System of Equations:

3.8 Gauss-Jordan elimination Method,

3.9 Gauss-Seidel iteration method,

3.10 Gauss elimination method

3.11 Gauss-Jordan method to find inverse of a matrix.

3.12 Power method

3.13 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

24P3PHYT11EL: MICROELECTRONICS AND SEMICONDUCTOR DEVICES

Credits: 4 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 (20 Hrs)**

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 – DMA

1.4 8085 Microprocessor – Architecture

1.5 8085 addressing modes, instruction set, Pin out diagram,

1.6 Simple programming concepts.

UNIT II: **8086 Microprocessor (16 Hrs)**

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. Simple Programming concepts - Familiarisation with Debug utility

2.5. 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 junction: Schottky barrier diode - qualitative characteristics – ideal junction properties

4.2 Current voltage relationship, Comparison of Schottky barrier diode with pn junction diode

4.3 Metal semiconductor Ohmic contacts

4.3 Ideal Nonrectifying barriers– 4.3.2 tunneling barrier – specific contact resistances

4.4 Semiconductor hetero-junctions – hetero-junction materials – energy band diagram – 4.5.Two dimensional electron gas 4.6 equilibrium electrostatics – current voltage characteristics.

Recommended 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

24P3PHYT12EL: 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

1.16 FIR, IIR, stable and unstable systems

1.17Correlation 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

24P4PHYP03: COMPUTATIONAL PHYSICS PRACTICALS

Total credits: 3 Total hours: 180

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/ Python 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 an exponential curve to the given set of data using method of least square without 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 without 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.

24P4PHYP04: ADVANCED ELECTRONICS PRACTICALS

Total credit: 3 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.

SEMESTER IV

24P4PHYT13: ATOMIC AND MOLECULAR PHYSICS

Total Credits: 4 Total Hours: 72

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; fine structure in sodium atom

1.3 Normal Zeeman effect; Anomalous Zeeman effect- magnetic moment of the atom and g factor; 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;

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 interaction

4.3 CW NMR spectrometer; Magnetic Resonance Imaging.

4.4 Electron Spin Resonance(ESR)-Principle of ESR; thermal equilibrium and relaxation; ESR spectrometer; characteristics of the g-factor.

4.5 Total Hamiltonian for an electron; Hyperfine Structure- ESR spectrum of hydrogen atom.

4.6 Mossbauer effect - recoilless emission and absorption; Experimental techniques in Mossbauer spectroscopy

4.7 Isomer shift; quadrupole interaction; magnetic hyperfine interaction.

Recommended 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

24P4PHYT14: NUCLEAR AND PARTICLE PHYSICS

Total Credits: 4 **Total Hours: 72**

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, and 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)

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

3.2 Reaction cross sections, Coulomb scattering- Rutherford formula, and 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.

Recommended 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

24P4PHYT15EL: COMMUNICATION SYSTEMS

Total Credits: 3 Total Hours: 54

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:Introduction to Digital and Mobile communication (22 hrs)

1.1. Digital Communication Systems- Multiplexing techniques -Frequency division multiplex - Time division multiplexing- Digital transmission techniques:-ASK- FSK-PSK.

1.2. Introduction to Wireless Communication Systems -Mobile Radio System Around the World- Examples of wireless communication systems: - Paging system-Cordless Telephone System- Cellular Telephone System—Comparison of Common Mobile Radio Systems- Trends in Cellular and Personal Communications

1.3 Wireless communication systems—2G-3G - 4G

1.4 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

1.5 Basic idea of Path Loss and Multipath Fading

1.6 Multiple Access Techniques – Introduction-FDMA-TDMA-SSMA:- FHMA-CDMA-Hybrid Spread Spectrum Techniques-SDMA

1.7 GSM.

UNIT II: Satellite Communication (16 hrs)

2.1 Satellite Communication Fundamentals-Satellite Orbits-Satellite Positioning-Frequency Allocations-Polarization-Antennas—gain-beam width-Multiple Access Techniques

2.2 Geostationary Satellite communication-Satellite parameters

2.3VSAT (Basic Idea)

2.4 Geostationary Satellite Path/Link Budget

2.5 Satellite TV Systems-Satellite TV broadcasting

2.6GPS.

UNIT III :**Radar Systems (16 hrs)**

3.1 Basic Principles –Fundamentals:- Basic radar Systems-Development of Radar-Radar Performance Factors:—Radar range equation-factors influencing maximum range-Effects of noise- Target properties

3.2 Pulsed Systems-Block diagram and description-Antennas and Scanning:-Antennas Scanning- Antenna tracking-Display Methods

3.3 Pulsed radar systems-Moving Target Indication:- Doppler Effect-Fundamentals of MTI-Delay Line- Blind speeds-Radar Beacons

3.4 Other radar systems-CW Doppler Radar-Frequency Modulated CW Radar-Phased Array Radars- Planar Array Radars.

Recommended Text Books:

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

Recommended References:

1. 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.

ELECTIVE 4:
24P4PHYT16EL: OPTOELECTRONICS

Credits: 4 Hours: 72

The course is designed to give a deeper understanding of the physics of to the students in:

(i) semiconductor junctions, LEDs and optical fibers
(ii) lasers, particularly different semiconductor based ones
(iii) photodetectors and photovoltaics
(iv) various optical modulators and nonlinear optics

Unit I

Semiconductor Science and Light Emitting Diodes (10 hrs)

Semiconductor energy bands - semiconductor statistics – extrinsic semiconductors – compensation doping – degenerate and non-degenerate semiconductors – energy band diagrams in applied field - direct and indirect bandgap semiconductors, - p-n junction principles - open circuit- forward and reverse bias – depletion layer capacitance – recombination life time – p-n junction band diagram - open circuit - forward and reverse bias – light emitting diodes – principles - device structures - LED materials, heterojunction high intensity LEDs – double heterostructure – LED characteristics and LEDs for optical fiber communications - surface and edge emitting LEDs.

Text Book

1. Optoelectronics and Photonics: Principles and Practices, S.O. Kasap, Pearson 2009, (Chapter 3)

Fiber Optics (10 Hrs)

Symmetric planar dielectric slab waveguide – waveguide condition – single and multimode waveguides – TE and TM modes – modal and waveguide dispersion in the planar waveguide – dispersion diagram – intermodal dispersion – intramodal dispersion – dispersion in single mode fibers – material dispersion – waveguide dispersion – chromatic dispersion – profile and polarization dispersion – dispersion flattened fibers - bit rate and dispersion – optical and electrical bandwidth – graded index optical fiber - light absorption and scattering – attenuation in optical fibers.

Text Book:

1. Optoelectronics and Photonics: Principles and Practices, S.O. Kasap, Pearson (2009), (Chapter 2)

Unit II

Laser Principles (10 hrs)

Laser oscillation conditions - diode laser principles - heterostructure laser diode – double heterostructure – stripe geometry – buried heterostructure – gain and index guiding - laser diode characteristics – laser diode equation - single frequency solid state lasers – distributed feedback – quantum well lasers - vertical cavity surface emitting laser - optical laser amplifiers.

Text Book:

1.Optoelectronics and Photonics: Principles and Practices, S.O. Kasap, Pearson(2009),(Chapter 4)

Laser Output Control (6 hrs)

Generation of high power pulses, Q-factor, Q-switching for giant pulses, methods of Q-switching, mode locking and techniques for mode locking.

Text Book:

1. Laser fundamentals, William T. Silfvast, CUP 2nd Edn. (2009), (Chapter 13)

Unit III

Photodetectors and Photovoltaics (18 hrs)

Principle of p-n junction photodiode - Ramo's theorem and external photocurrent - absorption coefficient and photodiode materials - quantum efficiency and responsivity - PIN-photodiode – avalanche photodiode – phototransistor - photoconductive detectors and photoconductive gain - noise in photo-detectors – noise in avalanche photodiode - solar energy spectrum - photovoltaic device principles – I-V characteristics - series resistance and equivalent circuit - temperature effects - solar cell materials, device and efficiencies.

Text Book

1. Optoelectronics and Photonics: Principles and Practices, S.O. Kasap, Pearson (2009), (Chapter 5 & 6)

Unit IV

Optoelectronic Modulators (10 Hrs)

Optical polarization, birefringence, retardation plates, electro-optic modulators – Pockels effect - longitudinal and transverse electro-optic modulators, Kerr effect, Magneto-optic effect, acousto-optic effect – Raman Nath and Bragg-types.

Text Books:

1. Fiber optics and Optoelectronics, R.P. Khare, Oxford University Press, (2004), (Chapter 9)
2. Optoelectronics: An Introduction, J. Wilson and J.F.B. Hawkes, PHI, (2000), (Chapter 3)

Non-linear optics (8 Hrs)

Wave propagation in an anisotropic crystal - polarization response of materials to light - second order non-linear optical processes - second harmonic generation - sum and frequency generation, optical parametric oscillation - third order non-linear optical processes - third harmonic generation - intensity dependent refractive index - selffocusing - non-linear optical materials, phase matching - angle tuning - saturable absorption - optical bistability - two photon absorption.

Text Book:

1. Laser fundamentals, William T. Silfvast, CUP 2nd Edn. 2009

5. MODEL QUESTION PAPER

M Sc Physics, Degree (C.S.S) Examination

First Semester

Faculty of Science

Course Code-24PPHYT04-ELECTRONICS

(2024 admissions onwards)

Time: Three hours Max. Weight: 30

Section- A

(Answer any **eight** questions. Each question carries a weight of 1)

1. Write a note on the Noise in op-amps.
2. Define CMRR and explain its significance of large value of CMRR?
3. What is thermal drift? How does it affect the performance of an op-amp circuit?
4. What does the term, ‘roll off rate’ means?
5. Define supply voltage sensitivity? What is meant by poorly regulated power supply?
6. What is the offset-minimizing resistor, R_{OM}? Why it is not needed in differential op-amp circuits?
7. Draw the equivalent circuit diagram of an Op-amp?
8. In what way is the voltage follower a special case of the non-inverting amplifier?
9. Give two reasons, why an open-loop op-amp is unsuitable for liner applications?
10. What is meant by zero-crossing detector?

(8 x 1 = 8)

Section B

(Answer any **six** questions. Each question carries a weight of 2)

11. The 741C op-amp having the following parameters is connected as a closed loop non-inverting amplifier with R_1=1 KΩ and R_F=10 KΩ: A=200,000, R_i=2 MΩ, Ro=75Ω, f_o=5Hz, supply voltage=±15 V, output voltage swing=±13 V. Compute the values of A_F, R_{iF},R_{oF},f_{oF} and V_{ooT}.
12. Determine the output voltage in each of the following cases for an open-loop differential amplifier (a) v_{in1}=5 μV dc, v_{in2}=-7 μV dc, (b) v_{in1}=10 mV rms, v_{in2}= 20 mV rms. The op-amp is a 741 with the following specifications A=200000, R_1=2 MΩ, Ro=75 Ω , +V_{CC}=+15 V, -V_{EE} = -15 V and the output voltage swing =±14 V.

13. Compute the maximum possible total output offset voltage V_{out} of the inverting amplifier. Assume that the OP-amp is a LM 307 with supply voltage =±15 V, R_1 =1 KΩ, R_F=10 KΩ and R_L=10Ω K.

14. A completely compensated inverting amplifier using LM307, if V_{in} is a 10 mV peak sine wave at 1 kHz, a. Calculate E_v and V_o values at 55^{0}C b. Draw the output voltage waveform at 55^{0}C. Given specifications are $\Delta V_{io}/\Delta T$=30μV/^{0}C, are $\Delta I_{io}/\Delta T$=300 pA/^{0}C, Vs=± 15 V, R_1=1 KΩ, R_F=100 KΩ, R_L=100 KΩ.

15. For a differential amplifier using two op-amps, R1= R3= 6.8 KΩ, vx=-1.5 V pp, and vy=-2 V pp sine waves at 1 KHz. The op-amp is 741C. Calculate (a) the voltage gain and the input resistance and (b) the output voltage of the amplifier. Assume that the output is initially nulled (VOOT=0 V). Given A=200,000, Ri=2 MΩ, Ro=75Ω, fo=5Hz, supply voltage=±15 V, output voltage swing=±13 V.

16. With suitable circuit diagrams, explain ac and dc amplifiers

17. Determine the stability of the voltage follower circuit using IC 741C.

18. In the Schmitt trigger R_1=150 Ω, R_2=68 KΩ, R_L=10 KΩ, V_{in}=500 mV pp sine wave and saturation voltages =±14V. Determine the threshold voltages V_{ut} and V_{lt}. What is the value of the hysteresis voltage V_{hy}.

(6 x 2 = 12)

<u>Section C</u>

(Answer any **two** questions. Each question carries a weight of 5)

19. With the help of suitable diagrams, obtain the equation, which can be used to design the offset-voltage compensating network in an op-amp. (b) Design a compensating network for the LM307 op-amp. Draw the circuit diagram. The op-amp uses ± 10 V supply voltages. (The input offset voltage specified in the data sheet for LM307 is 10 mV).

20. What is a differential amplifier? With a circuit and necessary theory, derive expressions for voltage gain and input resistances of differential amplifiers using a single Op-amp?

21. (a) Discuss the theory of operation of a second order low pass filter using op-amp.

    (b) Design a second order low-pass filter at a high cutoff frequency of 1 kHz. Also draw the frequency response of the same.

22. Explain briefly the working of a voltage-controlled oscillator?

(2 x 5 = 10)