ST. TERESA’S COLLEGE, (AUTONOMOUS)
ERNAKULAM

CURRICULUM FOR
M.Sc. PROGRAMME IN PHYSICS

UNDER CREDIT AND SEMESTER SYSTEM
(2014 Admissions)

Foreword

The higher education environment is changing rapidly in India,and particularly so in the year 2014-15,when the government of Kerala decided to give autonomy to thirteen educational institutions in the state ,with the aim of improving quality.Quality in higher education has been a matter of high concern and priority in india especially after the National Policy on Education,1986 has very categorically questioned the impact of education and suggested many measures for bringing innovative practices in education.

St.Teresa's College, Ernakulam has been sanctioned autonomy vide UGC letter No.f.22-1-2014(AC) dated 19/6/2014 .The college has decided to function as autonomous from the academic year 2014-15.

The academic year 2014-15 will follow the same syllabus and guidelines as per MG University.

CHAPTER – I

1. GENERAL SCHEME OF THE SYLLABI

1.1 Theory Courses: There are sixteen theory courses spread equally in all four semesters in the M.Sc. Programme. Distribution of theory courses is as follows. There are twelve core courses common to all students. Semester I and Semester II will have **four** core courses each and Semester III and Semester IV will have **two** core courses each. **Two** elective courses each will come in Semester III and Semester IV. The fourth Elective course appearing in Semester IV is the Open Elective Course. There are four Elective Bunches and an Open Elective Bunch offered in this syllabus. An Elective Bunch has three theory courses while the Open Elective Bunch has four theory courses. A college can choose one Elective Bunch and any one course from the Open Elective Bunch in one academic year.

1.2 **Practicals:** All four semesters will have a course on laboratory practicals. The laboratory practicals of Semesters I, II and III are common courses. The Semester IV laboratory practical course will change, subject to the Elective Bunch opted by the college. A minimum of 12 experiments should be done and recorded in each semester. The practical examinations will be conducted at the respective examination centers by two external examiners appointed by the university at the end of even semesters only. The first and second semester examinations of laboratory practical courses will be conducted at the end of Semester II while the third and fourth semester practical examinations will be conducted at the end of Semester IV.

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

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

1.5 **Course Code:** The 12 core courses in the programmme are coded according to the following criteria. The first three letters of the code indicates the name of programme, ie. PHY stands for Physics. One digit to indicate the semester. i.e. PHY1 (Physics, 1^{st} Semester). The last letters indicates the name of the course.

Laboratory Practical course codes are appended with (P). The course code of project/dissertation is PHY4(PD). The course code of viva voce is PHY4VV. The letters PD and VV stand for dissertation of the project and viva voce respectively.

1.6 Course Structure of M.Sc. Physics Programme:

This is the PG programme followed by all affiliated colleges under Mahatma Gandhi University. Apart from this, three affiliated colleges have one more PG progamme in Physics with different course structures. This is discussed in Chapter IV. The detailed structure of the Core courses common to all students of the programme is given in

Table 1.1.

SEM	course code	Name of the course	No.of Hrs/ week	No. of cred it	Total Hrs/ SEM.
I	**PHY1MMP**	Mathematical Methods in Physics- I	4	4	72
I	**PHY1CM**	Classical Mechanics	4	4	72
I	**PHY1ED**	Electrodynamics	4	4	72
I	**PHY1ELE**	Electronics	4	4	72
I	**PHY1GP(P)**	General Physics Practicals	9	3	162
II	**PHY2MMP**	MathematicalMethodsinPhysics- II	4	4	72
II	**PHY2QM**	Quantum Mechanics - I	4	4	72
II	**PHY2TSM**	Thermodynamics and Statistical Mechanics	4	4	72
II	**PHY2CMP**	Condensed Matter Physics	4	4	72
II	**PHY2ELE(P)**	Electronics Practicals	9	3	162
III	**PHY3QM**	Quantum Mechanics - II	4	4	72
III	**PHY3CP**	Computational Physics	4	4	72
III	**PHY3CP(P)**	Computational Physics Practicals	9	3	162
IV	**PHY4AMP**	Atomic and Molecular Physics	4	4	72
IV	**PHY4NP**	Nuclear and Particle Physics	4	4	72
IV	**PHY4(PD)**	Project/Dissertation	Nil	2	Nil
IV	**PHY4(VV)**	Viva Voce	Nil	2	Nil

Table 1.1: Structure of PGCSS Physics M.Sc. Common Courses

1.7 The Elective Bunches:

There are four Electives Bunches offered in this PGCSS Programme. Each elective consists of a bunch of **three** theory courses and **one** laboratory course. The first two theory courses of a bunch are placed in the Semester III, while the third theory course and the laboratory course go to the Semester IV. An institution can select only one Elective Bunch in an academic year. The course structure of the Electives Bunches is given in Table 1.2

The Electives Bunches are named,

(i) Bunch A: Electronics
(ii) Bunch B: Informatics
(iii) Bunch C: Material Science
(iv) Bunch D: Theoretical Physics

Elective	SEM	course code	Name of the course	No. of Hours per week	No. of Credit	Total hours per SEM
Bunch A: Electronics	III	**PHY3IED**	Integrated Electronics and Digital Signal Processing	4	4	72
	III	**PHY3MES**	Microelectronics and semiconductor devices	4	4	72
	IV	**PHY4ICE**	Instrumentation and communication electronics	4	4	72
	IV	**PHY4AE(P)**	Advanced Electronics Practical	9	3	162
Bunch B: Informatics	III	**PHY3DCI**	Data Communication and Internet working	4	4	72
	III	**PHY3JLS**	Java and Linux Operating System	4	4	72
	IV	**PHY4CAP**	Computer Application in	4	4	72

			Physics			
	IV	**PHY4IE(P)**	Practicals- Informatics Elective	9	3	162
Bunch C: Material Science	III	**PHY3SSP**	Solid state physics	4	4	72
	III	**PHY3CGT**	Crystal Growth Technique	4	4	72
	IV	**PHY4NC**	Nanostructures and Characterization	4	4	72
	IV	**PHY4MS(P)**	Material Science Practical	9	3	162
Bunch D: Theoretical Physics	III	**PHY3AP**	Astrophysics	4	4	72
	III	**PHY3ND**	Nonlinear Dynamics	4	4	72
	IV	**PHY4QFT**	Quantum Field Theory	4	4	72
	IV	**PHY4SC(P)**	Special Computational Practicals	9	3	162

Table 1.2: Course Structure of Electives

1.8 The Open Elective Bunch: The Open Elective Bunch has four specialized theory courses. A college has the choice to select any one of these courses. The 4th theory course of the Semester IV comes from the open elective bunch. The course structure of Open Elective Bunch is given in Table 1.3 below. The change of Elective Bunch/Open Elective course is permitted with proper request application to the relevant body of the University.

SEM	Name of the course with course code	No. of Hrs/ week	No. of credit	Total Hrs./ SEM.
IV	**PHY4OE:**Optoelectronics	4	4	72
IV	**PHY4SEW:**Software Engineering and Web design	4	4	72
IV	**PHY4TFN:**Thin films and Nanoscience	4	4	72
IV	**PHY4GRC:**General Relativity and Cosmology	4	4	72

Table 1.3: Open Elective Courses

1.9 Distribution of Credit: The total credit for the programme is fixed at 80. The distribution of credit points in each semester and allocation of the number of credit for theory courses, practicals, project and viva is as follows. The credit of theory courses is 4 per course, while that of laboratory practical course is 3 per course. The project and viva voce will have a credit of 2 each. The distribution of credit is shown in Table 1.4. Distribution of the credit remains unchanged for parallel PG programmes in physics, discussed in Chapter IV.

Semester	Cources	Credit	Total credit
I	4 Theory classes	4 x 4 = 16	16
II	4 Theory classes 2 Laboratory practical	4 x 4 = 16 2 x 3 = 6	22
III	4 Theory classes	4 x 4 = 16	16
IV	4 Theory classes 2 Laboratory practical 1 Project/Dessertation 1 Viva-voce	4 x 4 = 16 2 x 3 = 6 1 x 2 = 2 1 x 2 = 2	26
Total credit of the MSc programme			80

Table 1.4: Distribution of creditin the PGCSS Programme.

CHAPTER - II

2. GRADING AND EVALUATION

2.1 Examinations

The evaluation of each course shall contain two parts such as Internal or In-Semester Assessment (IA) and External or End-Semester Assessment (EA). The ratio between internal and external examinations shall be 1:3. The Internal and External examinations shall be evaluated using Direct Grading system based on 5-point scale.

2.2 Internal or In-Semester Assessment (IA)

Internal evaluation is to be done by continuous assessments of the following components. The components of the internal evaluation for theory and practicals and their weights are as in the Table 2.1. The internal assessment should be fair and transparent. The evaluation of the components should be published and acknowledged by students. All documents of internal assessments are to be kept in the institution for 2 years and shall be made available for verification by the university. The responsibility of evaluating the internal assessment is vested on the teacher(s) who teach the course. The two test papers should be in the same model as the end semester examination question paper, the model of which is discussed in the Section 2.3. The duration and the number of questions in the paper may be adjusted judiciously by the college for the sake of convenience.

THEORY		PRACTICALS	
Component	Weights	Component	Weights
Attendance	2	Attendance	2
Assignments	2	Laboratory Involvement	2
Seminar	2	Test [*Best of Two*]	2
Test - I	2	Record	2
Test - II	2	Viva	2
Total Weight of Theory = 10		Total Weight of Practicals = 10	

Table 2.1: Distribution of weights and components of theory and practical

2.2.1 Attendance, Assignment and Seminar

The split up of Attendance grade and different components of Assignment and Seminar is given in the Table 2.2. Monitoring of attendance is very important in the credit and semester system. All the teachers handling the respective courses are to document the attendance in each semester. Students with attendance less than 75% in a course are not eligible to attend external examination of that course. The performance of students in the seminar and assignment should also be documented.

Attendance		Assignments		Seminar	
%of Attendance	Grade	Components	Weig-hts	Components	Weig-hts
≥ 90 %	A	Punctuality	1	Innovation of Topic	1
≥ 85 % and < 90%	B	Review	2	Review/ Reference	1
≥ 80 % and	C	Content	4	Content	3

< 85%					
≥ 75 % and < 80%	D	Conclusion	2	Presentation	3
<75 %	E	References	1	Conclusion	2

Table 2.2: split up of attendance grade and components of Seminar & Assignment

2.2.2 Project Evaluation

The internal evaluation of the project is done by the supervising guide of the department or the member of the faculty decided by the head of the department. The project work may be started at the beginning of the Semester III. The supervising guide should keenly and sincerely observe the performance of the student during the course of project work. The supervising guide is expected to inculcate in student(s), the research aptitude and aspiration to learn and aim high in the realm of research and development. A maximum of three students may be allowed to perform one project work if the volume of the work demands it.

Project evaluation begins with (i) the selection of problem, (ii) literature survey, (iii) work plan, (iv) experimental / theoretical setup/data collection,

(v) characterization techniques/computation/analysis (vi) use of modern software for data analysis/experiments (Origin, LABView, MATLAB, …etc) and (vi) preparation of dissertation. The project internal grades are to be submitted at the end of Semester IV. The internal evaluation is to done as per the following general criteria given in Table 2.3

Component	**Weights**
Literature Survey	3
Experimental/Theoretical setup/Data Collection	4
Result and Discussion	3

Table 2.3: Criteria for internal evaluation of Project

2.2.3 General Instructions

(i) The assignments/ seminars / test papers are to be conducted at regular intervals. The time for conduct of two test papers will be notified by the university from time to time. These should be marked and promptly returned to the students.

(ii) One teacher appointed by the Head of the Department will act as a coordinator for consolidating grade sheet for internal evaluation in the department in the format supplied by the University. The consolidated grade sheets are to be published in the department notice board, one week before the closing of the classes for end semester examinations. The grade sheet should be signed by the coordinator and counter signed by the Head of the Department and the college Principal.

(iii) The consolidated grades in specific format supplied by the university are to be kept in the college for future references. The consolidated grades in each course should be uploaded to the University Portal at the end of each semester as directed by the University.

(iv) A candidate who fails to register for the examination in a particular semester is not eligible to continue in the subsequent semester.

(v) Grievance Redress Mechanism for Internal evaluation: There will be provision for grievance redress at four levels, viz,

a) at the level of teacher concerned,
b) at the level of departmental committee consisting of Head of the Department, Coordinator and teacher concerned,
c) at the level of college committee consisting of the Principal, Head of the Department and one member of the college council, nominated by the principal each year,
d) at the university level committee consisting of Pro-Vice Chancellor / Dean of the Faculty, the controller of examinations and the Convener of the Standing Committee on Academic Affairs of the Syndicate. College level complaints should be filed within one week of the publication of results and decisions taken within two the next two weeks. University level complaints will be

made within the time stipulated by the University and decisions will be taken within one month of the last date fixed for filing complaints.

2.3 External Evaluation (EA)

The external examination of all semesters shall be conducted by the university on the close of each semester. There will be no supplementary examinations.

2.3.1 Question Paper Pattern for Theory Courses.

All the theory question papers are of three hour duration. All question papers will have three parts.

Part A: Questions from this part are very short answer type. Six questions have to be answered from among ten questions. Each question will have weight one and the Part A will have a total weight of six. A minimum of two questions must be asked from each unit of the course.

Part B: Part B is fully dedicated to solving problems from the course concerned. Four problems out of six given have to be answered. Each question has a weight two making the Part B to have total weight eight. A minimum of one problem from each unit is required. The problems need not always be of numerical in nature.

Part C: Part C will have four questions. Two questions of equal standard must be asked from each unit with internal option. Each question will have a weight four making the total weight sixteen in Part C

2.3.2 Directions for question setters

(i) Follow the as far as possible the text book specified in the syllabus.

(ii) The question paper should cover uniformly the entire syllabus. For that the section 2.3.1 should be strictly followed.

(iii) Set Part A questions to be answered in five minutes each, Part B questions in ten minutes each and Part C questions in twenty five minutes each.

Weightage to objectives and difficulty levels in the question paper should be as given in the Table 2.4 below.

Weightage to Objectives		Weightage to Difficulty Levels	
Objective	%	Level of Difficulty	%
Information	20	Easy	30
Understanding	60	Average	50
Application	20	Difficult	20

Table 2.4: Weightage to objectives and difficulty levels

2.3.3 Practical, Project and Viva Voce Examinations

Practical Examination: First and second semester practical examinations are conducted at the end of Semester II and third and fourth semester practical examinations are conducted at the end of Semester IV. The practical examinations are conducted immediately after the second and fourth semester theory examinations respectively. There will be two practical examination boards every year to conduct these practical exams. All practical examinations will be of five hours duration. Two examiners from the panel of examiners of the university will be deputed by the board chairman to each of the examination centers for the fair and transparent conduct of examinations. Practical examination is conducted in batches having a maximum of eight students. The board enjoys the right to decide on the components of practical and the respective weights.

Project Evaluation: The project is evaluated by the two external examiners deputed from the board of practical examination. The dissertation of the project is examined along with the oral presentation of the project by the candidate. The examiners should ascertain that the project and report are genuine. Innovative projects or the results/findings of the project presented in national seminars may be given maximum advantage. The supervising guide or the faculty appointed by the head of the department may be allowed to be present at the time of project evaluation. This is only to facilitate proper evaluation of the project. The different weight for assessment of different components is shown in Table 2.5.

Viva Voce Examination: Viva voce examination is conducted only by the two external examiners of the board of practical examinations. The viva voce examination is given a credit two. The examination should be conducted in the following format shown in Table 2.6 below.

Component	**Weights**
Quality of project under study	1
Presentation of the project	3
Experimental/Theoretical setup/Data Collection	4
Result and Dissertation layout	2

Table 2.5: Components and weights of Project

Type of Questions	Percentage	Weightage to Difficulty Level	
B.Sc/ + 2 level	20	Level of Difficulty	%
M.Sc. Syllabus Based	40	Easy	30
Subject of Interest	20	Average	50
Advanced Level	20	Difficult	20

Table 2.6: Format for viva voce Examination

Both project evaluation and viva voce examination are to be conducted in batches of students formed for the practical examinations.

2.3.4 Reappearance/Improvement: For reappearance / improvement as per university rules, students can appear along with the next regular batch of students of their particular semester. A maximum of two chances will be given for each failed paper. Only those papers in which candidate have failed need be repeated. Chances of reappearance will be available only during eight continuous semesters starting with the semester in which admission/readmission is given to the candidate.

CHAPTER - III

3. M. Sc. PHYSICS SYLLABUS

3.1 Introduction:

This chapter deals with the Syllabi of all Core courses, Elective courses and Open Elective courses of the M.Sc. Physics Programme under Credit and Semester System. The semester wise distribution of the courses is given. In Semester III and Semester IV, the courses from Elective Bunches and Open Elective Bunch will come as opted by the colleges concerned. The titles of the courses with course codes of all categories of courses are discussed in the Chapter – I.

3.2 CORE COURSES

SEMESTER - I

PHY1MMP MATHEMATICAL METHODS IN PHYSICS – I

Unit I

Vectors and Vector Spaces (18 Hrs)

Integral forms of gradient, divergence and curl, Line, surface and volume integrals – Stoke's, Gauss's and Green's theorems - Potential theory - scalar, gravitational and centrifugal potentials. Orthogonal curvilinear coordinates - gradient, divergence and curl in Cartesian, spherical and cylindrical co-ordinates. Equation of continuity - Linear vector spaces - Hermitian, unitary and projection operators with their properties- inner product space - Schmidt orthogonalization - Hilbert space - Schwartz inequality.

Text Books

1. Mathematical Methods for Physicists, G.B. Arfken &H.J. Weber 4^{th} Edition,

Academic Press (Chapter 1 & 2)

2. Mathematical Physics, P.K Chattopadhyay, New Age International (chapter 7)
3. Theory and problems of vector analysis, Murray R. Spiegel (Schaum's outline series)

Unit II

Matrices (12 Hrs)

Direct sum and direct product of matrices, diagonal matrices, Matrix inversion (Gauss-Jordan inversion method) orthoganal, unitary and Hermitian matrices, normal matrices, Pauli spin matrices, Cayley-Hamilton theorem. Similarity transformation - unitary and orthogonal transformation. Eigen values and eigenvectors – Diagonalisation using normalized eigenvectors. Solution of linear equation-Gauss elimination method. Normal modes of vibrations.

Text Books

1. Mathematical Methods for Physicists, G.B. Arfken &H.J. Weber 4th Edition, Academic Press (Chapter 3)
2. Mathematical Physics, P.K Chattopadhyay, New Age International (Chapter 7)

Probability theory and distributions (6 Hrs)

Elementary probability theory, Random variables, Binomial, Poisson and Gaussian distributions-central limit theorem.

Text Books

1. Mathematical methods for Physics and Engineering, K.F. Riley, M.P Hobson, S. J. Bence, Cambridge University Press (Chapter 24)
2. Mathematical Methods for Physicists, G.B. Arfken &H.J. Weber 4th Edition, Academic Press. (Chapter 19)

Unit III

Differential Geometry (16 Hrs)

Definition of tensors, basic properties of tensors. Covariant, contravariant and mixed tensors. Levi-Civita tensor, Metric tensor and its properties, Tensor algebra, Christoffel symbols and their transformation laws, covariant differentiation, geodesic equation, Riemann-Christoffel tensor, Ricci tensor and Ricci scalar.

Text Books

1. Introduction to Mathematical Physics, Charlie Harper, PHI
2. Vector analysis and tensors, Schaum's outline series, M.R. Spiegel, Seymour Lipschutz, Dennis Spellman, McGraw Hill
3. Mathematical Physics, B.S. Rajput, Y. Prakash 9th Ed, Pragati Prakashan (Chapter 10)
4. Tensor Calculus: Theory and problems, A. N. Srivastava, Universities Press

Unit IV

Special functions and Differential equations (20 Hrs)

Gamma and Beta functions, different forms of beta and gamma functions, evaluation of standard integrals. Dirac delta function, Kronecker Delta - properties and applications.

Bessel's differential equation – Bessel and Neumann functions – Legendre differential equation - Associated Legendre functions- Hermite differential equation - Laguerre differential equation – Associated Laguerre polynomials. (Generating function, recurrence relations, and orthogonality condition for all functions), Rodrigue's formula

Text Books

1. Mathematical Methods for Physicists, G.B. Arfken &H.J. Weber 4th Edition, Academic Press
2. Mathematical Physics, B.S Rajput, Pragati Prakashan

Reference Books:

1. Mathematical Physics, B.D. Gupta, Vikas Pub.House, New Delhi
2. Advanced Engineering Mathematics, E. Kreyszig, 7th Ed., John Wiley
3. Introduction to mathematical methods in physics, G.Fletcher, Tata McGraw Hill
4. Advanced engineering mathematics, C.R. Wylie, & L C Barrett, Tata McGraw Hill
5. Advanced Mathematics for Engineering and Physics, L.A. Pipes & L.R. Harvill, Tata McGraw Hill

6. Mathematical Methods in Physics, J. Mathew & R.L. Walker, India Book House.
7. Mathematical Physics, H.K. Dass, S. Chand & Co. New Delhi.

Blue Print

Units	**Hours**	**1 Weight 6/10**	**2 Weight 4/6**	**4 Weight 4/8**	**Total Weightage 30/54**
Unit I	18	3	1	2	13
Unit II	18	2	2	2	14
Unit III	16	2	1	2	12
Unit IV	20	3	2	2	15

St. Teresa's College (Autonomous), Ernakulam

First Semester M. Sc. Physics Degree Examination

PHY1MMP: Mathematical Methods in Physics I

Model question paper

Time: 3 hrs Total weightage: 30

Part A

(Answer any 6 questions, each question carries weightage 1)

1. State Green's theorem

2. Define Unitary operator with an example.
3. Define projection operator and mention its two properties
4. What are the properties of Pauli spin matrices?
5. Explain Poisson distribution with one example.
6. Define outer product of tensors.
7. Prove that $\delta^i_j = N$.
8. Define Dirac delta function. State one situation where it finds application
9. Write down the associated Legendre equation.
10. Explain what is meant by a Neumann function.

(6 x 1 = 6)

Part B

(Answer any 4 questions, each question carries weightage 2)

11. Determine unit vectors in Spherical coordinates and prove that they are orthogonal.
12. Diagonalise the matrix A = $\begin{bmatrix} 3 & 1 & 1 \\ 1 & 3 & 2 \\ 2 & 2 & 3 \end{bmatrix}$
13. Explain elementary probability theory. In a box, there are 8 red, 7 blue and 6 green balls. One ball is picked up randomly. What is the probability that it is neither red nor green?
14. Prove that single contraction of a tensor A^{ijk}_{lm} is a tensor of rank 3
15. Evaluate the following integrals using beta and gamma functions.

    i) $\int_a^b (b-x)^{m-1}\,(x-a)^{n-1}dx$, where m and n are positive integers

    ii) $\int_0^1 x^4\ (1-\ x^2)^{-1/2}$ dx

16. Obtain the orthogonality relation for Hermite polynomials

(4 x 2 = 8)

Part C

(Answer all questions, each question carries weightage 4)

17. (a) Define line, surface and volume integrals. Explain the theorems connecting these integrals.

Or

(b) Express the gradient, divergence and curl operators in Cartesian, spherical and cylindrical co ordinates.

18. (a) Discuss Hermitian, Unitary, and Orthogonal matrix with example. Show that eigen vectors of Hermitian matrix are orthogonal and eigen values are real.

Or

(b) Illustrate the application of the matrix technique in finding the normal modes of vibration of a CO_2 molecule.

19. (a) Write Christoffel symbols of I^{st} and II^{nd} kind and derive their transformation equations.

Or

(b) Write notes on i) Levi – Civita Tensor ii) Fundumental tensor iii) Ricci tensor iv) Ricci scalor

20. (a) Derive the Rodrigues Formula for Legendre polynomial of order n.

Or

(b) Obtain the series solution for the Bessel difference equation of order n.

PHY1CM CLASSICAL MECHANICS

Unit I

Hamiltonian Mechanics (10 Hrs)

Review of Newtonian and Lagrangian formalisms - cyclic co-ordinates - conservation theorems and symmetry properties - velocity dependent potentials and dissipation function - Hamilton's equations of motion - Least action principle - physical significance.

Text Book:

1. Classical Mechanics, H. Goldstein, C.P. Poole & J.L. Safko, Pearson, 3rd Ed., (Chap. 1, 2 & 8)

Variational Principle and Lagrange's equations (6 Hrs)

Hamilton's principle - calculus of variations – examples - Lagrange's equations from Hamilton's principle.

Text Book:

1. Classical Mechanics, H. Goldstein, C.P. Poole & J.L. Safko, Pearson, 3rd Ed., (Chapter 2)

Unit II

Mechanics of Small Oscillations (6 Hrs)

Stable and unstable equilibrium - two-coupled oscillators – Lagrange's equations of motion for small oscillations - normal co-ordinates and normal modes - oscillations of linear tri-atomic molecules.

Text Book:

1. Classical Mechanics, S.L. Gupta, V. Kumar & H.V. Sharma, Pragati Prakashan, 2007. (Chapter 8)

Canonical Transformations (7 Hrs)

Equations of canonical transformation- examples of canonical transformation - harmonic oscillator.

Text Book:

1. Classical Mechanics, H. Goldstein, C.P. Poole & J.L. Safko, Pearson, 3rd Ed. (Chapter 9)

Poisson brackets - Lagrange brackets - properties- equations of motion in Poisson bracket form - angular momentum Poisson brackets - invariance under canonical transformations.

Text Book:

1. Classical Mechanics, J.C. Upadhyaya, Himalaya, 2010. (Chapter 7)

Hamilton-Jacobi Theory (7 Hrs)

Hamilton-Jacobi equation for Hamilton's principal function - harmonic oscillator problem - Hamilton - Jacobi equation for Hamilton's characteristic function- action angle variables in systems of one degree of freedom - Hamilton-Jacobi equation as the short wavelength limit of Schroedinger equation.

Text Books:

1. Classical Mechanics, H. Goldstein, C.P. Poole & J.L. Safko, Pearson, 3rd Edn.

(Chapter 10)

2. Classical Mechanics, J.C. Upadhyaya, Himalaya, 2010. (Chapter 8)

Unit III

Central Force Problem (9 Hrs)

Reduction to the equivalent one body problem - equations of motion and first integrals - equivalent one-dimensional problem and classification of orbits - differential equation for the orbits – virial theorem - Kepler problem.

Text Book:

1. Classical Mechanics, H. Goldstein, C.P. Poole & J.L. Safko, Pearson, 3rd Ed.. (Chapter 3)

Rigid Body Dynamics (9 Hrs)

Angular momentum - kinetic energy - inertia tensor - principal axes - Euler's angles- infinitesimal rotations - rate of change of a vector - Coriolis force - Euler's equations of motion of a symmetric top - heavy symmetric top with one point fixed.

Text Book:

1. Classical Mechanics, G. Aruldhas, Prentice Hall 2009, (Chapter 8)

Unit IV

General Theory of Relativity (9 Hrs)

Principle of equivalence - principle of general covariance - motion of a mass point in a gravitational field - the Newtonian approximation - time dilation - rates of clocks in a gravitational field - shift in the spectral lines – energy-momentum tensor- Einstein's field equations and the Poisson approximation.

Text Book:

1. The Theory of Relativity, R.K. Pathria, Dover Pub. Inc. NY,2003 (Chap 6,7& 8)

Classical Chaos (9 Hrs)

Linear and non-linear systems - integration of linear equation: Quadrature method - the pendulum equation – phase plane analysis of dynamical systems – phase curve of simple harmonic oscillator and damped oscillator- phase portrait of the pendulum - bifurcation - logistic map – attractors - universality of chaos - Lyapunov exponent - fractals - fractal dimension.

Text Book:

1. Classical Mechanics, G. Aruldhas, Prentice Hall 2009, (Chap.11& 12)

Reference Books:

1. Classical Mechanics, N.C. Rana and P.S. Joag, Tata Mc Graw Hill
2. Introduction to Classical Mechanics, R.G. Takwale and P.S. Puranik, TMGH.
3. Langrangian and Hamiltonian Mechanics, M.G. Calkin, World Scientific Pub.Co Ltd
4. Introduction to General Relativity, R. Adler, M. Bazin, M. Schiffer, TMGH.
5. An introduction to general relativity, S. K. Bose, Wiley Eastern.
6. Relativistic Mechanics, Satya Prakash, Pragathi prakashan Pub.
7. Chaos in Classical and Quantum Mechanics, M.C.Gutzwiller, Springer, 1990.
8. Deterministic Chaos, N. Kumar, University Press,
9. Chaotic Dynamics, G.L.Baker & J.P.Gollub, Cambridge Uni. Press, 1996
10. Mathematical Methods for Physicists, G.B. Arfken &H.J. Weber 4th Edition

Blue Print

Units	**1 Weight (6/10)**	**2 weight (4/6)**	**4 weight (4/8)**	**Total weightage**
Unit I	3	1	2	13
Unit II	2	2	2	14
Unit III	2	2	2	14
Unit IV	3	1	2	13

ST.TERESA'S COLLEGE, ERNAKULAM (AUTONOMOUS)
M.Sc. DEGREE (C.S.S) EXAMINATION
First Semester

PHY1CM – CLASSICAL MECHANICS

Time: Three hours Maximum Weight: 30

Part A

*Answer any **six** questions.*
Each question carries a weight of 1

1. What is the weak law of action and reaction?
2. Define constraints. How do they simplify the equations of motion?
3. What are cyclic coordinates? Give an example.
4. Define action angle variables.
5. Define Poisson Brackets. Discuss its properties
6. What is fictitious potential energy? Illustrate with an example.
7. What is Coriolis force? What is its effect on projective shot in the northern and southern Hemisphere of earth?
8. What is fractal dimension? How is it computed?
9. What is curvature tensor? What is its relevance in general theory of relativity?
10. Explain principle of equivalence and principle of general covariance.

(6 x 1=6)

Part B

*Answer any **four** questions.*
Each question carries a weight of 2

11. Outline the principle of least action. Show that the shortest distance between two points in a plane is a straight line.
12. Show that the transformation $P = \frac{1}{2}(p^2 + q^2)$, Q=$\tan^{-1}\frac{q}{p}$ is canonical.
13. Solve harmonic oscillator problem using action angle variables.
14. Solve the nonlinear equation of motion $d^2 x/dt^2+bx^3=0$.
15. For a system representing perfect gas prove that $\frac{3}{2}$ $NK_BT=\frac{3}{2}PV$.

16. Find the gravitational field of Sun. Assume that the gravitational field of earth can be neglected compared to that of Sun. The fractional change in frequency of a photon as it enters from gravitational field of sun to that of earth is 2.12×10^{-6}.

(4 x 2 = 8)

Part C

*Answer **all** questions.*

Each question carries a weight of 4.

17. (a)Derive Lagrange's equation from D'Alembert's principle. How will the equations get modified in the presence of velocity dependent potentials?

    OR

    (b) Derive Lagrange's equation from Hamilton's principle. Extend this to nonholonomic systems.

18. (a) Obtain Lagrange's Equation of motion for small oscillation in terms of normal coordinates.

    OR

    (b)Solve Kepler's Problem using Hamilton Jacobi Method.

19. (a) Derive the elliptical orbit equation for a particle moving in a central force which obeys inverse square law.

    OR

    (b) Describe the dynamics of heavy symmetric top with one point fixed

20. (a) Derive Einstien's field equations with the help of Poisson approximation.

    OR

    (b) Discuss the logistic map with respect various features of chaos

(4 x 4 = 16)

PHY1ED ELECTRODYNAMICS

Unit I

Electrostatic fields in matter and Electrodynamics (10 Hrs)

Review of Electrostatics and Magnetostatics, Time varying fields and Maxwell's equations, Potential formulations, Gauge transformations, boundary conditions, wave equations and their solutions, Poynting theorem, Maxwell's stress tensor.

Electromagnetic waves (8 Hrs)

Maxwell's equations in phasor notation. Plane waves in conducting and non-conducting medium, Polarization, Reflection and transmission (Normal and Oblique incidence), Dispersion in Dielectrics, Superposition of waves, Group velocity.

1. Text Book: 1. Introduction to Electrodynamics, David J. Griffiths, PHI

Unit II

Relativistic Electrodynamics (18 Hrs)

Structure of space time: Four vectors, Proper time and proper velocity, Relativistic dynamics - Minkowiski force, Magnetism as a relativistic phenomenon, Lorentz transformation of electromagnetic field, electromagnetic field tensor, electrodynamics in tensor notation, Potential formulation of relativistic electrodynamics.

Text Book:

2. Introduction to Electrodynamics, David J. Griffiths, PHI

Unit III

Electromagnetic Radiation (20 Hrs)

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

Text Book: 1. Introduction to Electrodynamics, David J. Griffiths, PHI

Unit IV

Antenna, Wave Guides and Transmission Lines (16 Hrs)

Radiation resistance of a short dipole, Radiation from quarter wave monopole or half wave dipole. Antenna parameters. Waves between parallel conducting plane TE, TM and TEM waves, TE and TM waves in Rectangular wave guides, Impossibility of TEM waves in rectangular wave guides. Transmission Lines-Principles-Characteristic impedance, standing waves-quarter and half wavelength lines

Text Books:

1. Electromagnetic waves and radiating systems, E.C. Jordan & K.G. Balmain PHI, 1968

2. Antenna and wave guide propagation, K. D Prasad, Satya Prakashan.

Reference Books:

1. Antennas, J.D Kraus, Tata Mc-Graw Hill.
2. Classical Electrodynamics, J. D. Jackson, Wiley Eastern Ltd.
3. Electromagnetic fields, S. Sivanagaraju, C. Srinivasa Rao, New Age International.
4. Introduction to Classical electrodynamics, Y. K. Lim, World Scientific, 1986.
5. Electromagnetic Waves and Fields, V.V. Sarwate, Wiley Eastern Ltd, New Age Inernational
6. The Feymann Lectures in Physics, Vol. 2, R.P. Feymann, R.B. Leighton & M. Sands.
7. Electronic Communication Systems, G. Kennedy & B. Davis, TMH.

Blue Print

Units	Hours	1 Weight 6/10	2 Weight 4/6	4 Weight 4/8	Total Weightage 30/54
Unit I	18	3	1	2	13
Unit II	18	1	2	2	13
Unit III	20	4	2	2	16
Unit IV		2	1	2	12

	16				

St. Teresa's College (Autonomous), Ernakulam

First Semester M. Sc. Physics Degree Examination

PHY1ED ELECTRODYNAMICS

Model question paper

Time: 3 hrs Total weightage: 30

Part A

(Answer any 6 questions, each question carries weightage 1)

1. Explain how Maxwell modified Ampere's circuital law?
2. Explain boundary conditions for electric field and magnetic field?
3. Briefly describe Maxwell's stress tensor.
4. Show that current density 4-vector is divergenceless.
5. Define Minkowski force. Interpret physically its zeroth component.
6. Define retarded potential.
7. What is meant by radiation reaction?
8. Define the directivity and power gain of an antenna.
9. What do you mean by SWR of a transmission line?
10. Define directive gain of antenna.

(6 x 1 = 6)

Part B

(Answer any 4 questions, each question carries weightage 2)

11. Calculate the reflection coefficient for light at an air-to-silver interface ($\mu_1 = \mu_2 = \mu_0$, $\varepsilon_1 = \varepsilon_0$, $\sigma = 6 \times 10^7$ $(\Omega m)^{-1}$, at optical frequencies ($\omega = 4 \times 10^{15}$ /s).
12. An electromagnetic wave propagates in free space along the Z-direction. The electric field vector is given by $\vec{E} = \hat{i}\, E_0 \cos \omega(\frac{z}{c} - t) + \hat{j}\, E_0 \tan \omega(\frac{z}{c} - t)$. Obtain the direction and magnitude of Poynting's vector.
13. Show that $\vec{E}.\vec{B}$ is relativistically invariant.
14. Obtain the Jefimenkos equation.

15. Find the characteristic impedance of a transmission line.
16. A standard air filled rectangular waveguide with dimensions a = 8.636 cm, b = 4.318 cm is fed by a 4 GHz carrier from a coaxial cable. Determine if a TE_{10} mode will be propagated. If so, calculate the phase velocity and the group velocity.

(4 x 2 = 8)

Part C

(Answer all questions, each question carries weightage 4)

17. (a) Discuss the reflection and transmission of electromagnetic waves at a dielectric surface at normal incidence. Show that R + T = 1.

Or

(b). Derive Maxwell's equation in matter.

18. (a) Derive the relativistic transformation rules for electric and magnetic fields.

Or

(b). Describe 1) proper time and proper velocity 2) relativistic energy and momentum 3) relativistic potentials.

19. (a) Discuss the radiation from an oscillating magnetic dipole.

Or

(b). Obtain equation for electric field of a moving point charge using Lienard-Wiechert potential.

20. (a) Obtain the expressions for the field and power radiated by a quarter wave monopole antenna. Calculate its radiation resistance.

Or

(b). Discuss the wave propagation in a rectangular wave guide.

(4×4 =16)

PHY1ELE ELECTRONICS

Unit I

Semiconductor Devices (5 Hrs)

FET devices - structure, characteristics, frequency dependence and applications

Text Book:

1. Fundamentals of Semiconductor Devices, Betty Anderson, Richard Anderson, TMH. (Chapter 7, 8 and 9)

Op-amp with Negative Feedback (13 Hrs)

Differential amplifier – Inverting amplifier – Non-inverting amplifier -Block diagram representations – Voltage series feedback: Negative feedback – closed loop voltage gain – Difference input voltage ideally zero – Input and output resistance with feedback – Bandwidth with feedback – Total output offset voltage with feedback – Voltage follower. Voltage shunt feedback amplifier: Closed loop voltage gain – inverting input terminal and virtual ground - input and output resistance with feedback – Bandwidth with feedback - Total output offset voltage with feedback – Current to voltage converter- Inverter. Differential amplifier with one op-amp and two op-amps.

Text Book:

1. Op-amps and linear integrated circuits, R.A. Gayakwad 4^{th} Edn. PHI, (Chapter 2 & 3)

Unit II

The Practical Op-amp (6 Hrs)

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

Text Book:

1. Op-amp and linear integrated circuits, R.A. Gayakwad 4^{th} Ed. PHI. (Chapter 4)

General Linear Applications (with design) (12 Hrs)

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

Text Book:

1 Op-amps and linear integrated circuits, R.A. Gayakwad 4th Ed. PHI. (Chap. 6)

Unit III

Frequency Response of an Op-amp (6 Hrs)

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

Text Book:

1. Op-amps and linear integrated circuits, R.A. Gayakwad 4th Edn.PHI, (Chap.5)

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

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

Text Book:

1. Op-amps and linear integrated circuits, R.A. Gayakwad 4th Ed. PHI, (Chap. 7)

Unit IV

Comparators and Converters (8 Hrs)

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

1. Op-amps and linear integrated circuits R.A. Gayakwad 4th Edn. PHI. (Chap. 8)

IC555 Timer (3 Hrs)

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

Text Book:

1. Op-amps and linear integrated circuits R.A. Gayakwad 4th Edn. PHI. (Chap. 10)

Analog Communication (7 Hrs)

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

Text Book:

1. Electronic Communication Systems, Kennedy & Davis 4thEd.TMH, (Chap. 6)

Reference Books:

1. Electronic Devices (Electron Flow Version), 9/E Thomas L. Floyd, Pearson
2. Fundamentals of Electronic Devices and Circuits 5th Ed. David A. Bell, Cambridge.
3. Electronic Communications Dennis Roddy and John Coolen, 4th Ed. Pearson.
4. Modern digital and analog communication systems, B.P. Lathi & Zhi Ding 4th Ed., Oxford University Press.
5. Linear Integrated Circuits and Op Amps, S Bali, TMH

Blue Print

Units	Hours	1 Weight 6/10	2 Weight 4/6	4 Weight 4/8	Total Weightage 30/54
Unit I	18	3	1	2	13
Unit II	18	2	2	2	14
Unit III	18	2	1	2	12
Unit IV	18	3	2	2	15

St. Teresa's College (Autonomous), Ernakulam
First Semester M. Sc. Physics Degree Examination
PHY1ELE - ELECTRONICS
Model question paper

Time: 3 hrs Total weightage: 30

Part A

(Answer any 6 questions, each question carries weightage 1)

1. Explain the operation of zero crossing detectors?
2. Distinguish between triangular and saw tooth waves?
3. What is the difference between A/D and D/A converters?
4. What are active filters?
5. Define break frequency and band width.
6. Define input offset voltage in an op amp.
7. Draw the circuit diagram of a subtractor in differential configuration.
8. What are characteristics of an ideal op amp?
9. What is the difference between voltage series and voltage shunt feed back?
10. Discuss the effect of negative feed back in non inverting amplifiers.

(6 x 1 = 6)

Part B

(Answer any 4 questions, each question carries weightage 2)

11. (i) Draw the schematic diagram of a phase shift oscillator. (ii) A phase shift oscillator with C= 0.1μF, R = 3.9kΩ, R_F=29R_1, What is the frequency of oscillation?
12. In the Schmidtt trigger R_1= 150Ω, R_2 = 68kΩ, R_L = 10 kΩ, V_{in} = 50mV_{pp}, sine wave and saturation voltage = ±14V. (a) Determine the threshold voltages V_{ut} and V_{lt}.(b) What is the value of hysteresis voltage V_{hy}.
13. Discuss the frequency response of internally compensated and noncompensated op amps.
14. What is thermal drift?. Give the graphical variation of input bias current, input offset current and input offset voltage with the temperature.
15. Compute the maximum possible total output offset voltage in an op amp circuit with following specifications: V_{io} = 7.5mV maximum, I_{io} = 50 nA maximum,I_B = 250 nA maximum at T_A = 25˚C , R_F =10kΩ and R_1= 1 kΩ.
16. An inverting amplifier with R_1 =470 Ω and R_F= 2R1assume that the opamp IC 741 has A =200,000, R_i = 2 MΩ, R_o = 75 Ω, F_o = 5Hz, Supply voltage= ±15V, output voltage swing = ±13V. Compute the vaues of A_F, R_{iF}, R_{oF} and f_F.

(4 x 2 = 8)

Part C

(Answer all questions, each question carries weightage 4)

17. (a) What is meant by heterodyning? Give the block diagram of a super heterodyne radio receiver and explain the function of each unit in it.

Or

(b). Explain the working of a volage to frequency converter.

18. (a) What is the important characteristics of a butterworth filter? With the help of a diagram explain the operation of low pass butterworth filter.

Or

(b). Describe the working of a comparator and a square wave generator using op amp.

19. (a) Discuss the working of an instrumentation amplifier using a transducer bridge and give its application as a temperature indicator.

Or

(b). Discuss the working of an op amp as summing and averaging amplifier in the inverting and noninverting configurations.

19. (a) (i) Draw the block diagram of a voltage series feedback amplifier and identify each block and state its function.

(ii) Derive the expression for closed loop voltage gain in terms of open loop voltage gain with the help of circuit diagram.

Or

(b). What are two differential amplifier configurations? Briefly compare and contrast these two configurations.

(4×4 =16)

PHY1GP(P) GENERAL PHYSICS PRACTICALS

(Minimum of 12 Experiments with Error analysis of the experiment is to be done)

1. Y, n, σ Cornu's method (a) Elliptical fringes and (b) Hyperbolic fringes.
2. Absorption spectrum –KMnO4 solution / Iodine vapour – telescope and scale arrangement – Hartmann's formula or photographic method
3. Frank and Hertz Experiment – determination of ionization potential.
4. Hall Effect (a) carrier concentration (b) Mobility & (c) Hall coefficient.
5. Resistivity of semiconductor specimen–Four Probe Method.
6. Band gap energy measurement of silicon.
7. Magnetic Susceptibility-Guoy's method / Quincke's method.
8. Michelson Interferometer - λ and dλ / thickness of mica.
9. Ultrasonic-Acousto-optic technique-elastic property of a liquid.
10. B - H Curve-Hysteresis.
11. Oscillating Disc-Viscosity of a liquid.
12. e/m of the electron-Thomson's method. Characteristic of a thermistor - Determination of the relevant parameters.
15. Dielectric constant of a non-polar liquid.
16. Dipole moment of an organic molecule (acetone).
17. Young's modulus of steel using the flexural vibrations of a bar.
18. Verification of Stefan's law and determination of Stefan's constant of radiation
19. Temperature dependence of a ceramic capacitor and verification of Curie-Wiess law
20. Experiments using GM counter- absorption co-efficient of beta rays in

materials.

21. Multichannel analyzer for alpha energy determination.
22. Zeemann effect setup – measurement of Bohr magnetron
23. Photoelectric effect – determination of Plank's constant using excel or origin.
25. Magneto-optic effect (Faraday effect)- rotation of plane of polarization as a function of magnetic flux density.
26. Linear electro-optic effect (Pockels effect) – half wave voltage and variation of intensity with electric field.
27. Silicon diode as a temperature sensor.
29. Electrical and thermal conductivity of copper and determination of Lorentz number.

ST. TERESA'S COLLEGE, ERNAKULAM (AUTONOMOUS)
M. Sc. DEGREE (P.G.C.S.S) PRACTICAL EXAMINATION
M. Sc. PHYSICS – FIRST YEAR

PHY1GP(P)- GENERAL PHYSICS PRACTICALS

Model Question Paper

Time: 5 Hours **Maximum weightage: 30**

Instructions:

1. *Write the register number on the top of the additional sheet.*
2. *Copy the question marked X into the additional sheet.*
3. *No change in questions shall be allowed.*
4. *Write a brief procedure for the above question with necessary principle, formula with symbols explained, design of circuits, pattern of graphs etc.*
5. *Return the additional sheet within 30 minutes.*
6. *Start doing the experiment after filling the details such as your register number in the main sheet*
7. *Ensures that examiners have checked your reading before you wind up the experiment.* ***Record your observations in ink.***
8. *Write the units of the quantities in the top row of tabular column.*
9. *Show neatly the substitutions and calculations.*
10. *Error analysis of the experiments is to be done.*

11. After completing the experiment, write the result with unit.

1. By Cornu's Method, set up elliptical/ hyperbolic fringes and hence determine Young's Modulus, Rigidity Modulus and Poisson's ratio of the given material.
2. Setup an experiment to visualize the absorption spectrum of $KMnO_4$. Hence determine the wavelengths of the absorption bands by evaluating Hartmann's constants using standard mercury spectrum and scale and telescope arrangement.
3. Determine the Hall coefficient, carrier concentration and mobility of the given specimen by Hall effect experiment.
4. Determine the band gap energy of Si/Ge using a p-n junction diode.
5. Calibrate the given Silicon diode as a temperature sensor.
6. By acousto- optic technique determine the compressibility of the given liquid.
7. Determine the coefficient of viscosity of the given liquid by oscillating disc method.
8. Determine the ratio of the charge to mass of the electron by Thomson's Method.
9. Determine the resistance of the given semi conducting crystal at different temperatures by four – probe method. Hence calculate the band gap energy.
10. Determine the Steffan's constant of radiation.
11. Draw the resistance – temperature characteristics of a thermistor and determine the temperature coefficient of resistance and material parameter.
12. Determine the wavelength of the given Laser source using a reflection grating. Repeat the experiment with a grating having different grating element.
13. Study the beam profile of the given diode laser. Determine the spot size from the distribution.

SEMESTER – II

PHY2MMP MATHEMATICAL METHODS IN PHYSICS – II

Unit I

Complex Analysis (18 Hrs)

Functions of a complex variable - Analytic functions - Cauchy-Riemann equation - integration in a complex plane – Cauchy's theorem-deformation of contours - Cauchy's integral formula - Taylor and Laurent expansion-poles, residue and residue theorem – Cauchy's Principle value theorem - Evaluation of integrals.

Text Books:

1. Mathematical Physics, B.D. Gupta, Vikas Pub.House, New Delhi
2. Mathematical methods in Classical and Quantum Physics, T. Dass & S. K. Sharma, Universities Press (2009)
3. Introduction to Mathematical physics, Charlie Harper, PHI

Unit II

Integral Transforms (18 Hrs)

Introduction to Fourier series and Fourier integral form - Fourier transform - square wave, full wave rectifier and finite wave train – momentum representation of hydrogen atom ground state and harmonic oscillator. Laplace transform –inverse Laplace transform-properties and applications – Earth's nutation, LCR circuit, wave equation in a dispersive medium, damped, driven oscillator, solution of differential equations.

Text Books:

1. Mathematical Methods for Physicists, G.B. Arfken &H.J. Weber 4th

Edition, Academic Press.

2. Mathematical Physics, H.K Dass & Dr. Rama Verma, S. Chand &Co.

Unit III

Group theory (18 Hrs)

Introductory definition and concepts of group - point group, cyclic group, homomorphism and isomorphism-classes, reducible and irreducible representations-Schur's Lemmas and Great Orthogonality theorem. Group character table- C2V, C3V and C4V groups, Lie group, concept of generators- rotation group SO(2), SO(3), Unitary Group SU(2) and SU(3) Homomorphism between SU(2) and SO(3) – Irreducible Representation of SU(2).

Text Books:

1. Elements of Group Theory for Physicists, A.W. Joshi, New Age India
2. Mathematical Physics, Sathyaprakash, Sultan Chand & Sons, New Delhi.
3. Group theory- Schaum's series, Benjamin Baumslag & Bruce Chandler, MGH.

Unit IV

Partial Differential Equations (18 Hrs)

Characteristics and boundary conditions for partial differential equations. Nonlinear partial differential equations – separation of variables in Cartesian, cylindrical and spherical polar coordinates. Heat equation, Laplace's equation and Poisson's equation. Nonhomogeneous equation - Green's function - symmetry of Green's function - Green's function for Poisson equation, Laplace equation and Helmholtz equation - Application of Green's function in scattering problem

Text Books:

1. Mathematical Methods for Physicists, G.B. Arfken & H.J. Weber 4th Edition, Academic Press.
2. Mathematical Physics, B.S Rajput, Pragati Prakashan

Reference Books:

(Given Under **PHY1MMP**)

Blue Print

PHY2MMP–MATHEMATICAL METHODS IN PHYSICS II

Units	Hours	1 Weight 6/10	2 Weight 4/6	4 Weight 4/8	Total Weight 30/54
Unit I	18	2	2	2	14
Unit II	18	2	2	2	14
Unit III	18	3	1	2	13
Unit IV	18	3	1	2	13

St. Teresa's College (Autonomous), Ernakulam
Second Semester M. Sc. Physics Degree Examination
PHY2MMP–MATHEMATICAL METHODS IN PHYSICS II

Model Question Paper

Time: Three Hours **MaximumWeight: 30**

Part A

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

1. Define residue of a function. Give the different ways of evaluating the residue.
2. State the condition for a function f(Z) of a complex variable Z to be continuous at $Z=Z_0$.
3. Explain sine and cosine Fourier series?
4. Write translation or shifting property of Laplace transform.
5. Show that Laplace transform is a linear operation.
6. What is a SU(2) group?
7. State and Explain Schur's lemma1.
8. Check whether the equation is linear or nonlinear
9. Write Poisson's differential equation and mention its application in Physics
10. Briefly explain symmetry property of Green's function.

(6 x 1 = 6)

Part B

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

11. Given w(x,y) = u(x,y)+ i v(x,y). If u and v are real functions and w is analytic show that $\nabla^2 u = \nabla^2 v = 0$.
12. Find Laurent's expansion for f(Z) = $\frac{1}{Z(Z-2)}$ in the region a) 0<$|Z|$< 2 and b) 2<$|Z|$<∞.
13. Solve $y'' + 4y' + 4y = e^{-t}$ using Laplace transform, given y(0) = 0 and $y'(0)$ = 0.
14. Find the Fourier series of $f(x) = \begin{cases} 0, & -2 < t < -1 \\ k, & -1 < t < 1 \\ 0, & 1 < t < 2 \end{cases}$
15. Show that the group of order two and three are always cyclic.
16. Find the potential inside and outside the sphere using zonal surface harmonics.

(4 x 2 = 8)

Part C

(Answer **all** questions. *Each question carries a weight of **4***)

17. (a) Obtain Laurent's expansion of a function f(Z) about $Z=Z_0$ and hence deduce Taylor expansion form it.

OR

(b) State and prove Cauchy's residue theorem and hence evaluate the integral $\oint_c \frac{dZ}{\sinh 2Z}$ where C is the Circle $|Z|$ =2, the contour being taken in the positive sense.

18. (a) What is Convolution theorem of Fourier transform. Find the Fourier transform of $f(x) = \begin{cases} 1, & -a < x < a, |x| < a \\ 0, & |x| > a > 0 \end{cases}$ then deduce $\int_0^\infty \sin t/t \ dt = \frac{\pi}{2}$ and $\int_0^\infty (\sin t/t)^2 \ dt = \frac{\pi}{2}$

OR

(b) The current 'I', charge 'q' in a series circuit containing an inductance L and capacitance C and the emf source E, satisfy the equation $L\frac{dI}{dt} + \frac{q}{C} = E$, $I = \frac{dq}{dt}$. Express 'I' and 'q' in terms of time. Given that L, C & E are constants and the initial values both I & q are zero.

19. (a) Discuss the character table of C_{4v} group.

OR

(b)Write notes on (i) SU(2) group, (ii) Abelian group (iii) Group of symmetries of an equilateral triangle.

20. (a) Solve Laplace's equation in spherical polar coordinates.

OR

(b) Solve linear flow in semi infinite solid where temperature on one face is sinusoidal function of time.

(4 x 4 = 16)

PHY2QM QUANTUM MECHANICS – I

Unit I

Basics of Quantum Mechanics (14 Hrs)

Stern - Gerlach experiment leading to vector space concept, Dirac notation for state vectors- ket space, bra space, inner products - algebraic manipulation of operators – unitary operators, eigenkets and eigenvalues – Hermitian operators-concept of complete set-representation of an operator by square matrix – matrix elements of an operator - expectation values of Hermitian and anti-Hermitian operators – generalized uncertainty product — change of basis-orthonormal basis and unitary matrix, transformation matrix-unitary equivalent observables-eigenkets of position-infinitesimal operator and its properties – linear momentum as generator of translation – canonical commutation relations – properties of wave function in position space and momentum space - relations between operator formalism and wave function formalism-momentum operator in position basis – momentum space wave function – computation of expectation values x, x^2, p and p^2 for a Gaussian wave packet.

Text Book:

1. Modern Quantum Mechanics, J. J. Sakurai, Pearson Education (Chapter 1)

Unit II

Quantum Dynamics (18Hrs)

Time evolution operator and its properties-Schrodinger equation for the time evolution operator - energy eigenkets - time dependence of expectation values - time energy uncertainty relation - Schrodinger picture and Heisenberg picture - behaviour of state kets and observables in Schrodinger picture and Heisenberg picture - Heisenberg equation of motion - Ehrenfest's theorem - time evolution of base kets - transition amplitude - energy eigenket and eigen values of a simple harmonic oscillator using creation and annihilation operators

Text Book:

1. Modern Quantum Mechanics, J.J. Sakurai, Pearson Education (Chapter 2)

Identical particles

Identity of particles - spin and statistics-Pauli's exclusion principle - Helium atom

Text Book:

1. Quantum Mechanics, V. K. Thankappan, New Age International, 1996,

(Chapter 9)

Unit III

Angular momentum (20 Hrs)

Commutation relation between infinitesimal and rotation-infinitesimal rotations in quantum mechanics-fundamental commutation relations of angular momentum - rotation operator for spin ½ system - Pauli two component formalism - Pauli spin matrices - 2x2 matrix representation of rotation operator – commutation relations for J^2, J_x – eigenvalues of J^2 and J_x - matrix elements of angular momentum operators - representation of the rotation operator – rotation matrix-properties of the rotation matrix-orbital angular momentum as a rotation generator - addition of angular momentum and spin angular momentum - addition of spin angular momenta and Clebsch-Gordon coefficients for two spin ½ particles

Text Book:

1. Modern Quantum Mechanics, J.J. Sakurai, Pearson Education,

Unit IV

Solutions of Schrodinger equation and Approximation Methods (20 Hrs)

Motion in a central potential - Hydrogen atom WKB approximation - WKB wave function –validity of the approximation - connection formula (proof not needed) potential well - barrier penetration variational methods - bound states – hydrogen molecule ion - stationary state perturbation theory – non degenerate case - anharmonic oscillator - degenerate case -applications - first order Stark effect and Zeeman effect in hydrogen

Text Book:

1. Quantum mechanics, V.K. Thankappan New Age International 1996 (Chapter 4, 8)
2. Quantum Mechanics, G Aruldhas, PHI, 2002, (Chapter 10)

Reference Books:

1. A Modern approach to quantum mechanics, John S. Townsend, Viva Books

MGH.
2. Basic Quantum Mechanics, A. Ghatak, Macmillan India 1996
3. Quantum Mechanics, an Introduction, W Greiner, Springer Verlag
4. Quantum Mechanics, E. Merzbacher, John Wiley, 1996
5. Introduction to Quantum Mechanics, D.J. Griffiths, Pearson.
6. Quantum Mechanics, L.I. Schiff, Tata McGraw Hill
7. A Text Book of Quantum Mechanics, P.M. Mathews & K. Venkatesan, TMGH.
8. Quantum Mechanics, Concepts and Applications, N. Zettily, John Wiley & Sons.
9. Fundamentals of Quantum Mechanics Y.R. Waghmare, S Chand & Co.

Blue Print

M. Sc. II Semester

PHY2QM QUANTUM MECHANICS – I

Units	Hours	1 Weight 6/10	2 Weight 4/6	4 Weight 4/8	Total Weight 30/54
Unit I	14	2	1	2	12
Unit II	18	3	2	2	15
Unit III	20	2	2	2	13
Unit IV	20	3	1	2	14

St. Teresa's College (Autonomous), Ernakulam
Second Semester M. Sc. Physics Degree Examination
PHY2QM – QUANTUM MECHANICS – 1
Model Question Paper

Time: Three Hours **Maximum Weight: 30**

Part A

*(Answer any **six** questions, Each question carries a weight of **1)***

1. Briefly discuss the momentum space wave functions.
2. What is a unitary operator? Explain its properties.
3. What are identical particles?
4. Distinguish between Schrödinger and Heisenberg pictures of quantum mechanics.
5. Write and explain the uncertainty relation involving time and energy.
6. Give the matrix elements of J_+ and J_-
7. What are Clebch Gordon coefficients? Give their properties.
8. How does the stationary state perturbation theory accommodate an operator having degenerate eigen values?
9. Explain why WKB approximations can only be applied to one - dimensional problems.
10. What are the energy levels which become non degenerate as first order corrections are included to explain Zeeman effect?

(6 × 1 = 6)

Part B

*(Answer any **four** questions, Each question carries a weight of **2**)*

11. If the Hamiltonian of a system is H = $\frac{p_x^2}{2m}$ + V(x), obtain the value of the commutator [x, H]. Hence, find the uncertainty product (Δx) (ΔH).
12. Briefly discuss on the harmonic oscillator eigen functions.

13. For the number operator N_k of a linear harmonic oscillator, show that (i) the commutator $[N_k, N_l] = 0$, and (ii) all positive integers including zero are the eigen values of N_k .
14. Compute (σ.a)(σ.b) and hence evaluate $(\sigma.a)^2$.
15. Find the 3 × 3 matrix representation of J_y for j=1.
16. Apply WKB approximation method to find out the wave functions in the presence of potential well.

(4 × 2 = 8)

Part C

*(Answer **all** questions, Each question carries a weight of **4**)*

17. a) What is a Gaussian wave packet? Calculate its uncertainty product.

OR

b) Discuss how Stern – Gerlach experiment shows the need of a complex abstract vector space to describe a quantum mechanical system.

18. a) Differentiate between Schrodinger picture and Heisenberg picture of quantum mechanics. Also derive the equations of motion in both pictures.

OR

b) Show that the symmetry character of the wave function provides an understanding of the qualitative features of the low lying levels of Helium atom.

19. a) Discuss the formal theory of addition of angular momentum. Illustrate with an example.

OR

b) What are ladder operators? Use them to find the relation between eigen values of J^2 and J_z Find the allowed eigen values of J_z

20. a) Describe the Schrodinger equation for motion in central potential and hence describe Hydrogen atom.

OR

b) Describe the Variational principle and get the ground state energy and wave function for Hydrogen molecule ion.

(4 × 4=16)

PHY2TSM THERMODYNAMICS AND STATISTICAL MECHANICS

Unit I

Fundamental of Thermodynamics (10 Hrs)

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.

Text Book:

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

Foundations of Statistical Mechanics (8 Hrs)

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

Text Book:

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

Unit II

The Canonical Ensemble (12 Hrs)

A system in contact with a heat bath – the partition function – definition of the entropy in the canonical ensemble – the bridge to thermodynamics through partition function – condition for thermal equilibrium – 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.

Text Book:

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

Statistics of Identical Particles (4 Hrs)

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

Text Book:

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

Unit III

Maxwell Distribution and Planck's Distribution (12 Hrs)

The probability that a particle is in a quantum state – density of states in k space – single particle density of states in energy – distribution of speeds of particles in a classical gas – blackbody radiation – Rayleigh-Jeans theory –

Planck's distribution – derivation of the Planck's distribution – the free energy – Einstein's model vibrations in a solid – Debye's model of vibrations in a solid.

Text Book:

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

Grand Canonical Ensemble (8 Hrs)

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

Text Book:

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

Unit IV

Fermi and Bose Particles (6 Hrs)

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

Text Book:

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

Phase Transitions (12 Hrs)

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

Text Book:

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

Reference Books:

1. Statistical Mechanics, R.K. Pathria, & P.D. Beale, 2nd Edn, B-H (Elsevier) (2004).
2. Introductory Statistical Physics, S.R.A. Salinas, Springer (2000).
3. Fundamentals of Statistical and Thermal Physics, F. Rief, McGraw Hill (1986).
4. Statistical Mechanics, Kerson Huang, John Wiley and Sons (2003).
5. Statistical Mechanics, Satyaprakash & Agarwal, Kedar Nath 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).

Blue Print

M. Sc. II Semester

PHY2TSM– THERMODYNAMICS AND STATISTICAL MECHANICS

Units	Hours	1 Weight 6/10	2 Weight 4/6	4 Weight 4/8	Total Weight 30/54
Unit I	18	3	1	2	13
Unit II	16	3	1	2	13
Unit III	20	2	2	2	14
Unit IV	18	3	1	2	14

St. Teresa's College (Autonomous), Ernakulam
First Semester M. Sc. Physics Degree Examination
PHY2TSM - THERMODYNAMICS AND STATISTICAL MECHANICS
Model Question Paper

Time: Three Hours **Maximum Weight: 30**

Part A
(Answer any six questions, each carries weight 1)

1. What are the qualities of a good thermometer?
2. What are the axioms of probability?
3. What do you mean by the term function of a state?
4. What is partition function? Why is it called so?
5. Obtain the expression for thermal de Broglie wavelength.
6. What do you mean by Pauli's exclusion principle?
7. Write down Wien's scaling law and obtain Wien's displacement law.
8. Define Gibb's free energy. How is it related to the chemical potential?

9. Give the distribution functions for fermions and bosons. Substantiate the difference between them.
10. Define thermodynamic potential. Give some examples.

(6 x 1 = 6)

Part B
(Answer any four questions, each carries weight 2)

11. What is the maximum possible efficiency of an engine that obtains heat at 250^0C and loses the waste heat at 60^0C?
12. Calculate the free energy of a system with N particles, each with spin 3/2 with one particle per site. Given that the levels associated with the four spin states have energies $\frac{3}{2}\varepsilon$, $\frac{1}{2}\varepsilon$, $-\frac{1}{2}\varepsilon$ and $-\frac{3}{2}\varepsilon$ and degeneracies 1, 3, 3, and 1 respectively.

Turn over

13. Calculate the single particle density of states in energy of a free particle in two dimensions.
14. Show that the internal energy density of black body radiation is proportional to the fourth power of temperature.
15. Calculate the Fermi temperature of electrons in Lithium with number density 4.6×10^{28} m^{-3}.
16. Write a short note on continuous phase transition citing examples.

(4 x 2 = 8)

Part C
(Answer all questions, each carries weight 4)

17. (a) Explain the concept of increase in entropy and show that entropy depends on internal energy, volume and number of particles.

OR

(b) Derive Maxwell's relations using laws of thermodynamics.

18. (a) Considering the translational motion of N noninteracting particles in three dimensions show that the contribution to specific heat capacity , $C_v = (3/2)\ Nk_BT$

OR

(b) What are identical particles? Explain symmetric and antisymmetric wave functions.

Obtain the Sackur-Tetrode formula for the entropy of an ideal gas.

19. (a) Discuss the Debye's model of lattice specific heat.

OR

(b) What is grand partition function? Obtain expressions for entropy, pressure and the average number of particles of a grand canonical ensemble in terms of grand partition function.

20. (a) Explain the significance of Bose Einstein Condensation.

OR

(b) Obtain the thermodynamic properties of Fermi gas at absolute zero of temperature.

(4 x 4 = 16)

PHY2CMP CONDENSED MATTER PHYSICS

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 - junction properties- metal-metal, metal-semiconductor and semiconductor-semiconductor junctions.

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)

Blue Print

M. Sc. II Semester

PHY2CMP–CONDENSED MATTER PHYSICS

Units	**Hours**	**1 Weight** **6/10**	**2 Weight** **4/6**	**4 Weight** **4/8**	**Total Weight** **30/54**
Unit I	18	2	2	2	14
Unit II	16	2	1	2	12
Unit III	20	3	2	2	15
Unit IV	18	3	1	2	13

St. Teresa's College (Autonomous), Ernakulam
First Semester M. Sc. Physics Degree Examination
PHY2CMP – CONDENSED MATTER PHYSICS

Model Question Paper

Time: Three Hours **Maximum Weight: 30**

Part A

(Answer any 6 questions. Each question has a weightage 1)

1. Define reciprocal lattice.
2. What is the Drude model of metals?
3. How does the position of Fermi level change in an extrinsic semiconductor when temperature is varied from very low to very high values?
4. What is diffusion length in a semiconductor?

5. What are molecular clusters?
6. Write a short note on thermal conductivity of solids.
7. What is piezo electricity? Give example of a piezoelectric material.
8. How is cooling produced by adiabatic demagnetization?
9. What are cooper pairs?
10. Explain the domain structure in ferromagnetic materials.

(6 x 1= 6)

Part B

(*Answer any 4 questions . Each question has a weightage 2)*

11. If a dust particle of 1 microgram requires 100 s to cross a distance of 1 mm which is the separation between two rigid walls of the potential, determine the quantum number described by this motion.

(Turn Over)

12. The intrinsic carrier density at 300 K in silicon is 1.5 x 10^{16} /m^3. If the electron and hole mobilities are 0.13 and 0.05 $m^2V^{-1}s^{-1}$ respectively, calculate the conductivity of intrinsic silicon.
13. Show that the Hall coefficient is independent of the applied magnetic field and is inversely proportional to the current density and electronic charge.
14. What ere ferroelectric materials? Discuss the Curie – Weirs law in ferroelectricity.
15. State Hunds' rules. Apply these rules to find out the electronic configuration of Ce^{3+} which has a single f electron.
16. The Debye temperature of diamond is 2000K. Calculate the mean velocity of sound in diamond, given the density and atomic mass of diamond as 3500 Kgm^{-3} and 12 amu respectively. If the interatomic spacing is 1.54A^o, estimate the frequency of the dominant mode of lattice vibration.

(4 x 2 = 8)

Part C

(Answer all questions. Each question has a weightage 4)

17. Derive Bragg's law in reciprocal space. Explain the significance of Laue equations and Ewald sphere.

Or

18. Explain the significance of FD statistics and FD distribution function in predicting the electronic specific heat of metals.
19. Discuss – How are materials classified into metals, semiconductors and insulators based on Kronig – Penney model?

Or

20. Derive expressions for free carrier concentration in intrinsic and extrinsic semiconductors.
21. Derive dispersion relationship for a one dimensional diatomic crystal. Show that the group velocity vanishes at the zone boundary

Or

22. Discuss the Einstein's model of specific heat. What were the drawbacks of the theory?
23. Discuss the quantum theory of paramagnetism and obtain an expression for the susceptibility of a paramagnetic material .

Or

24. S.T. the current flowing across a Josephson junction is oscillatory when a voltage is applied across the junction.

(4 x 4 = 16)

PHY2ELE(P) ELECTRONICS PRACTICALS

(Minimum of 12 experiments should be done)

1. R C Coupled CE amplifier - Two stages with feedback - Frequency response and voltage gain.
2. Differential amplifiers using transistors and constant current source -

Frequency response, CMRR.

3. Push-pull amplifier using complementary - symmetry transistors-power gain and frequency response.
4. R F amplifier - frequency response & band width - Effect of damping.
5. Voltage controlled oscillator using transistors.
6. Voltage controlled oscillator using IC 555
7. R F Oscillator - above 1 MHz frequency measurement.
8. Differential amplifier - using op-amp.
9. Active filters – low pass and high pass-first and second order-frequency response and roll off rate.
10. Band pass filter using single op-amp-frequency response and bandwidth.
11. Wein-bridge Oscillator – using op-amp with amplitude stabilization.
12. Op-amp-measurement of parameters such as open loop gain - offset voltage – open loop response.
13. Crystal Oscillator
14. RC phase shift oscillator
15. AM generation and demodulation
16. Solving differential equation using IC 741
17. Solving simultaneous equation using IC 741
18. Current to voltage and voltage to current converter (IC 741)
19. Temperature measurement using ADC and microprocessor.
20. Op-amp-triangular wave generator with specified amplitude.
21. µp - stepper motor control.
22. µp- measurement of analog voltage.
23. µp-Digital synthesis of wave form using D/A Converter.
24. Analog to digital and digital to analog converter ADC0800 & DAC0800

ST. TERESA'S COLLEGE, ERNAKULAM (AUTONOMOUS)

M. Sc. DEGREE (P.G.C.S.S) PRACTICAL EXAMINATION

M. Sc. PHYSICS– FIRST YEAR

PHY2ELE(P) ELECTRONICS PRACTICALS

Time: 5 Hours **Maximum weightage: 30**

Instructions:

12. *Write the register number on the top of the additional sheet.*
13. *Copy the question marked X into the additional sheet.*
14. *No change in questions shall be allowed.*
15. *Write a brief procedure for the above question with necessary principle, formula with symbols explained, design of circuits, pattern of graphs etc. .*
16. *Return the additional sheet within 30 minutes.*
17. *Start doing the experiment after filling the details such as your register number in the main sheet*
18. *Ensures that examiners have checked your reading before you wind up the experiment.* ***Record your observations in ink.***
19. *Write the units of the quantities in the top row of tabular column.*
20. *Show neatly the substitutions and calculations.*
21. *After completing the experiment, write the result with unit.*

1. Design and construct a differential amplifier using transistors with constant current source. Study the frequency response and calculate the CMRR of the circuit repeat for another different input amplitude.

2. Design and construct a first order and second order low pass butterworth filter for a cutoff frequency of 1 kHz. Draw the frequency response curve theoretically and experimentally and find the pass band gain and the roll-off rate. Compare it with the theoretical values.

3. Design and construct a first order low pass Butterworth filter for a cut-off frequency of 1kHz with a pass band gain of 2.Calculate the frequency response data theoretically and tabulate it. Draw the frequency response curve experimentally and find the pass band gain and the roll off rate.
   Convert this low pass filter to have a cut –off frequency of 2 kHz by using the frequency scaling technique and determine the frequency response as above.

4. Design and construct a first order high pass Butterworth filter for a cut-off frequency of 1kHz with a pass band gain of 2.Calculate the frequency response data theoretically and tabulate it. Draw the frequency response curve experimentally and find the pass band gain and the roll off rate.
   Convert this low pass filter to have a cut –off frequency of 2k Hz by using the frequency scaling technique and determine the frequency response as above.

5. Design and construct a second order high pass Butterworth filter for a cut-off frequency of 1kHz Calculate the frequency response data theoretically and tabulate it. Draw the frequency response curve experimentally and find the pass band gain and the roll off rate. Compare it with the theoretical values.
   Convert this high pass filter to have a cut –off frequency of 2kHz by using the frequency scaling technique and determine the frequency response as above.

6. Design and construct a second order low pass Butterworth filter for a cut-off frequency of 0.5kHz.Calculate the frequency response data theoretically and tabulate it. Draw the frequency response curve experimentally and find the pass band gain and the roll off rate. Compare it with the theoretical values.
   Convert this high pass filter to have a cut –off frequency of 2kHz by using the frequency scaling technique and determine the frequency response as above.

7. Design and construct a band pass filter for a frequency of 2 kHz with appropriate Q and A_F=10. Draw the frequency response curve and determine the bandwidth. Change the center frequency to 1kHz by keeping A_F constant. Draw the frequency response curve and determine the bandwidth.

8. With proper theory design and construct a Wein Bridge oscillator incorporating amplitude stabilization using op-amp for a frequency of 1kHz.Measure the frequency and amplitude of the oscillations. Design the oscillator and measure the outputs for 2kHz and 4kHz respectively.

9. Design and construct a voltage controlled oscillator using IC555 for T=1ms.Study the variation of output frequency with control voltage and compare it with the theoretical value. Also determine the duty cycle and compare with the theoretical value.

10. Design and construct a differential amplifier circuit using op-amp. Measure outputs for different input frequencies keeping input voltage constant in each mode. Hence calculate CMRR in each case and draw the variation of CMRR with frequency.

11. Design and construct an RC phase shift oscillator using op-amp to generate a frequency of 400Hz.Measure the amplitude and frequency of the generated wave. Design the oscillator to generate frequencies 600Hz, 1kHz, 2kHz, 3kHz and 5kHz and measure the amplitude and frequency.

12. Design and construct a first order and second order active low pass filter of cut off frequency 1kHz. Draw the frequency response and determine the roll off rate.

13. Design and construct a first order and second order active high pass filter of cut off frequency 1kHz. Draw the frequency response and determine the roll off rate.

14. Using an op-amp design and construct a triangular waveform generator for 2 kHz taking Vopp=5v. Measure the amplitude and frequency. Compare with theoretical values. Repeat the experiment for 3 kHz and 5kHz.

SEMESTER – III

PHY3QM QUANTUM MECHANICS – II

Unit I

Time Dependent Perturbation Theory (16 hrs)

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

Text Book:

1. Advanced Quantum Mechanics, J.J. Sakurai, Pearson Education (Chapter 5)
2. Quantum mechanics – V. K. Thankappan New Age Int. Pub 1996 (Chapter 8)

Unit II

Scattering (18 hrs) Asymptotic wave function and differential cross section, Born approximation, Yukawa potential, Rutherford scattering. The partial wave expansion, hard sphere scattering, S-wave scattering for the finite potential well, resonances - Ramsaur- Townsend effect

Text Book:

1. A Modern Approach to Quantum Mechanics, John S. Townsend, Viva Books Pvt Ltd, MGH (Chapter 13)

Unit III

Relativistic Quantum Mechanics (18 hrs)

Need for relativistic wave equation - Klein-Gordon equation - Probability conservation - covariant notation - derivation of Dirac equation - conserved current representation - large and small components - approximate Hamiltonian for electrostatic problem - free particle at rest -plane wave solutions - gamma matrices - bilinear covariant – relativistic covariance of Dirac equation - angular momentum as constant of motion.

Text Book:

1. Advanced Quantum Mechanics, J.J. Sakurai, Pearson Education (Chapter 3)

Unit IV

Elements of Field Theory (20 hrs)

Euler-Lagrange equation for fields - Hamiltonian formulation – functional derivatives -conservation laws for classical field theory - Noether's theorem - Non relativistic quantum field theory - quantization rules for Bose particles, Fermi particles - relativistic quantum field theory - quantization of neutral Klein Gordon field - canonical quantization of Dirac field – plane wave expansion of field operator - positive definite Hamiltonian

Text Book:

1. Field Quantization, W Greiner , J Reinhardt, Springer, (Chapter 2, 3, 4 & 5)
2. Quantum mechanics - V.K. Thankappan, New Age Int. Publishers

Reference Books:

(In addition to books given under PH2C06, the following books are also recommended)

1. Quantum Field Theory, Lewis H. Ryder, Academic Publishers, Calcutta,1989
2. Quantum Field Theory, Claude Itzykson & Jean Bernard Zuber, MGH, 1986
3. Introduction to Quantum Field Theory, S.J. Chang, World Scientific, 1990
4. Quantum Field Theory, Franz Mandl & Graham. Shaw, Wiley 1990

Blue Print

M. Sc. Physics (III Semester)

PHY3QM: Quantum Mechanics – II

Units	Hours	1 Weight 6/10	2 Weight 4/6	4 Weight 4/8	Total Weightage 30/54
Unit I	16	2	1	2	12
Unit II	18	2	2	2	14
Unit III	18	3	1	2	14
Unit IV	20	3	2	2	15

Questions from all the units of the syllabus shall be included in Parts A, B and C of the question paper. In Part A, a minimum of two questions must be asked from each unit. In part B, a minimum of one question has to be there from each unit. But there should not be more than two questions from a unit in Part B. In Part C, one question with internal choice from each Unit is to be included.

St. Teresa's College (Autonomous), Ernakulam
Third Semester M. Sc. Physics Degree Examination
PHY3QM QUANTUM MECHANICS – II

Model Question Paper

Time: Three Hours **Maximum Weight: 30**

Part A

(Answer any 6 questions, each question carries weightage 1)

1. Explain Dyson series.
2. What is meant by positive definite Hamiltonian?
3. What is differential scattering cross section?
4. What is Ramsaur –Townsend effect?
5. Write down the Klein-Gordon equation. What is the difficulty in interpreting the probability density according to it?
6. What are bilinear covariants?
7. What are the plane wave solutions of Dirac equation for free particles at rest?
8. Briefly discuss Noether's theorem and its significance.
9. Write a note about time evolution operator in interaction picture.
10. State and explain Fermi Golden rule.

Part B

(Answer any 4 questions, each question carries weightage 2)

11. A system in an unperturbed state n is suddenly subjectd to a constant perturbation H'(r) which exists during time $\rightarrow$ t 0. Find the probability of transition from state n to state k and show that it varies simple harmonically with angular frequency $(E_k-E_n)/2\hbar$. Also find its amplitude of transition.
12. Consider scattering by $V(r)=V_0\exp(-\alpha r)/r$, where V_0 and α are constants . In the limit $E \longrightarrow 0$ show that the differential scattering cross-section is independent of θ and φ.

13. Determine the phase shift at low energy for the potential

$$V(r) = \begin{cases} -V_0 & r < a \\ 0 & r > a \end{cases}$$

14. For a Dirac particle moving in a central potential, show that the orbital angular momentum is not a constant of motion.
15. Derive the Hamiltonian density of Dirac's field.
16. Show that when the wavelength of the radiation is large, the atom is approximated as a dipole.

Part C (Answer all questions, each question carries weightage 4)

17. Briefly explain Harmonic perturbation. Also derive the absorption cross section under harmonic perturbation.

OR

18. Explain sudden and adiabatic approximations.

19. Discuss the Born approximation for Scattering problem. Discuss the validity criterion for it.

OR

20. Discuss the phase shift analysis for Hard Sphere scattering.

21. Derive the Dirac equation and hence find the conserved current.

OR

22. Discuss the relativistic covariance of the Dirac equation.

23. Discuss the quantization of Klein-Gordon field.

OR

24. Derive Euler – Lagrange equation for the fields. What are functional derivatives?

PHY3CP COMPUTATIONAL PHYSICS

Unit I

Curve Fitting and Interpolation (20Hrs)

The least squares method for fitting a straight line, parabola, power and exponential curves with the help of principle of least square fit. Interpolation - Introduction to finite difference operators, Newton's forward and backward difference interpolation formulae, Lagrange's interpolation formula, Newton's divided difference formula with error term, interpolation in two dimensions. Cubic spline interpolation end conditions. Statistical tests - Ψ^{2-}test and T-test.

Unit II

Numerical Differentiation and Integration (16 Hrs)

Numerical differentiation, errors in numerical differentiation, cubic spline method - finding maxima and minima of a tabulated function - Integration of a function with Trapezoidal Rule, Simpson's 1/3 and 3/8 Rule and error associated with each. Romberg's integration, Gaussian integration method, Monte Carlo evaluation of integrals - numerical double integration

Unit III

Numerical Solution of Ordinary Differential Equations (20Hrs)

Euler method - modified Euler method and Runge - Kutta 4^{th} order methods - adaptive step size R-K method, predictor - corrector methods - Milne's method, Adam-Mouton method.

Numerical Solution of System of Equations

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

Unit IV

Numerical solutions of partial differential equations (16Hrs)

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

Text Books:

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

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.K Iyengar, 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, 4^{th} Edn, 1958

M.Sc Physics (III Semester)

PHY3CP COMPUTATIONAL PHYSICS

Blue Print

Units	Hours	1 Weight 6/10	2 Weight 4/6	4 Weight 4/8	Total Weight 30/54
Unit I	20	3	2	2	15
Unit II	16	2	1	2	12
Unit III	20	3	2	2	15
Unit IV	16	2	1	2	12

Questions from all the units of the syllabus shall be included in Parts A, B and C of the question paper. In Part A, a minimum of two questions must be asked from each unit. In part B, a minimum of one question has to be there from each unit. But there should not be more than two questions from a unit in Part B. In Part C, one question with internal choice from each Unit is to be included.

St. Teresa's College (Autonomous), Ernakulam
Third Semester M. Sc. Physics Degree Examination
PHY3CP - COMPUTATIONAL PHYSICS

Model Question Paper

Time: Three Hours **Maximum Weight: 30**

Part A

I. Answer any *SIX* of the following questions, (Each question carries a weight of 1)

1. Differentiate between interpolation and extrapolation.
2. Show that the operators μ and E commute.
3. By constructing a difference table and taking the second order difference as constant, Find the sixth term of the series 8,12,19,29 and 42.
4. State Simpson's 3⁄8 rule
5. Give Gauss formula for numerical intergration.
6. Point out the differences between Gauss elimination method and Gauss – Jordan elimination method.
7. Discuss the principle of Euler's method used for solving a differential equation.
8. How does the power method differ from Jacobi method?
9. Explain the concept of stability.
10. Why do we call Schmidt method as an explicit method?

(6 x 1 = 6)

Part B

II. Answer any *FOUR* of the following questions. (Each question carries a weight of 2)

11.What are divided differences? Give Newton's divided difference interpolation formula.

12.Using Newton's forward difference formulae calculate dy/dx and d^2y/dx^2 at x=1 from the table.

x	1	2	3	4	5	6
y	1	8	27	64	125	216

13. Using Lagrange's method find the value of y when x=8 from the following data

x	5	9	11	12
y	121	73	25	26

14.Solve the following system of equations

$$20x + y - 2z = 17$$

$$3x + 20y - z = -18$$

$$2x - 3y + 20z = 25$$

By Gauss – Seidal iterative method and perform first five iterations.

15. Explain the principle of predictor – corrector methods. Derive the predictor and corrector formulae in Adam – Moulton method

15. Explain weighted average implicit method. Why do we consider this as the most general implicit method.

(4 x 2 = 8)

Part C

III. Answer *ALL* the following questions. (Each question each carries a weight of 4)

16. (a) Fit the following points by cubic splines

x	1	2	4	6
y	10	5	2	1

find the value of y for x=1.5 by cubic splines using the initial condition $y_0'' = 0$ and $y_3'' = 0$.

OR

(b) Explain the least squares method of fitting a parabola through the given set of n observations.

17. (a) Derive the Gauss intergration formula when n=2 and apply it to evaluate the integral $\int_{-1}^{1} \frac{1}{1+x^2} dx$. Compare this result with that obtained by Simpson's ⅓ rule with h= 0.25.

OR

(b) Use the trapezoidal rule to evaluate the double integral $\int_{-2}^{2} \int_{0}^{4} (x^2 - xy + y^2)$dxdy.

18. (a) Describe Jacobi's method to find the eigen values and eigen vectors of a matrix. Find all the eigenvalues and the corresponding eigen vectors of the matrix $\begin{bmatrix} 3 & 2 & 1 \\ 2 & 3 & 2 \\ 1 & 2 & 3 \end{bmatrix}$

OR

(b) Solve the differential equation $\frac{dy}{dt} = t + y$ with the initial condition y(0) = 1, using fourth order Runge – Kutta method from t =0 to t=0.4 taking h = 0.1.

20. (a) Estimate the values at grid points for three time steps of the following equation using Bender-Schmidt method. Assume h= 1.$U_t = 5 U_{xx}$ with the boundary conditions U(0,t) = 0, U (5, t) = 60 and U(x, 0) = 20x, $0 \le x \le 3$, U(x,0) = 60 , $3 \le x \le 5$

OR

(b) What is Crank- Nicholson method? Using this method, solve the equation
$2F_{xx}(x, t) = F_t(x, t)$, $0 < t < 1.5$ and $0 < x < 4$.
Given the initial condition F(x, 0) =50 (4- x), $0 \le x \le 4$

and the boundary F (0 , t) = 0 , $0 \le t \le 1.5$ and F(4, t) = 0 , $0 \le t \le 1.5$

(4 x 4 = 16)

PHY3CP(P) COMPUTATIONAL PHYSICS PRACTICALS

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

1. Study the motion of a spherical body falling through a viscous medium and observe the changes in critical velocity with radius, viscosity of the medium.
2. Study the path of a projectile for different angles of projection. From graph find the variation in range and maximum height with angle of projection.
3. Study graphically the variation of magnetic field B(T) with critical temperature in superconductivity using the relationship $B(T) = B_0 [1 - (T/T_c)^2]$, for different substances.
4. Discuss the charging /discharging of a capacitor through an inductor and resistor, by plotting time –charge graphs for a) non oscillatory, b) critical) oscillatory charging.
5. Analyze a Wheatstone's bridge with three known resistances. Find the voltage across the galvanometer when the bridge is balanced.
6. Study the variation in phase relation between applied voltage and current of a series L.C.R circuit with given values of L C Find the resonant frequency and maximum current.
7. A set of observations of π meson disintegration is given. Fit the values to a graph based on appropriate theory and hence calculate life time τ of π mesons.
8. Draw graphs for radioactive disintegrations with different decay rates for different substances. Also calculate the half-life's in each case.
9. Half-life period of a Radium sample is 1620 years. Analytically calculate amount of radium remaining in a sample of 5gm after 1000 years.Varify your

answer by plotting a graph between time of decay and amount of substance of the same sample.

10. Plot the trajectory of a α-particle in Rutherford scattering and ditermine the values of the impact parameter.
11. Draw the phase plots for the following systems.
    (i) A conservative case (simple pendulum)
    (ii) A dissipative case (damped pendulum)
    (iii) A nonlinear case (coupled pendulums).
12. Two masses m_1 and m_2 are connected to each other by a spring of spring constant k and the system is made to oscillate as a two coupled pendulum. . Plot the positions of the masses as a function of time.
13. Plot the motion of an electron in (i) in uniform electric field perpendicular to initial velocity (ii) uniform magnetic field at an angle with the velocity. and (iii) simultaneous electric and magnetic fields in perpendicular directions with different field strengths.
14. A proton is incident on a rectangular barrier, calculate the probability of transmission for fixed values of V_0 and E ($V_0 > E$) for the width of barrier ranges from 5 to 10 Fermi, and plot the same.
15. Generate the interference pattern in Young's double slit-interference and study the variation of intensity with variation of distance of the screen from the slit.
16. Analyze the Elliptically and circularly polarized light based on two vibrations emerging out of a polarizer represented by two simple harmonic motions at right angles to each other and having a phase difference. Plot the nature of vibrations of the emergent light for different values of phase difference
17. Generate the pattern of electric field due to a point charge
18. Sketch the ground state wave function and corresponding probability distribution function for different values of dispalcements of the harmonic oscillator.
19. Gauss elimination method for solving a system of linear equations. Solving a

second order differential equation using 4^{th} order Runge- Kutta method.

20. Finding the roots of a nonlinear equation by bisection method.

Reference Books:

1. Computational physics, An Introduction, R.C. Verma, P.K. Ahluwalia & K.C. Sharma, New Age India, Pvt. Ltd.
2. An Introduction to computational Physics, Tao Pang, Cambridge University Press.
3. Simulations for Solid State Physics: An Interactive Resource for Students and Teachers, R.H. Silsbee & J. Drager, Cambridge University Press.
4. Numerical Recipes: the Art of Scientific Computing, W.H. Press, B.P. Flannery, S.A. Teukolsky & W.T.Vettering, Cambridge University Press.

ST. TERESA'S COLLEGE, ERNAKULAM (AUTONOMOUS)

M. Sc. DEGREE (P.G.C.S.S) PRACTICAL EXAMINATION

M. Sc. PHYSICS – IV Semester

PHY3CP(P) Computational Physics Practicals

Time: 5 Hours **Maximum weight: 30**

Instructions:

1. *Write the register number on the top of the additional sheet.*
2. *Copy the question marked X into the additional sheet.*
3. *No change in questions shall be allowed.*
4. *Write algorithm/ Flow chart and programme for the above question. Also write the Theory/ Method for each programme.*
5. *Return the additional sheet within 30 minutes.*

6. *Start doing the experiment after filling the details such as your register number in the main sheet*
7. *Ensures that examiners have checked compilation before you wind up the experiment.*
8. *For plotting the graph, use either a standard graphics software (Excel, Origin etc.) using an O/p file in the code or writing the graphics part in the code.*
9. *After completing the experiment, write the result .*

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1. Write and execute a C++ program to study the motion of a spherical body of known radius and mass in a viscous medium of known density and coefficient of viscosity and calculate the terminal velocity. Plot velocity- time graph. Study how the terminal velocity varies with the radius of the body.

2. Write and execute a C++ program to study the projectile motion of the body. Plot the x-y graph showing the path of the projectile. Study the variation of range with the angle of projection. Compute the range with at least 5 angles between 30 and 60. Plot a graph between range and angle and show that range is maximum for angle of projection 45.

3.Write and execute a C++ program to study graphically the variation of magnetic field B(T) with critical temperature in superconductivity using the relationship $B(T) = B_0[1-(T/Tc)^2]$. Repeat the programme for another three different substances.

4. Write and execute a program to study the motion of a spherical ball through a viscous liquid. Tabulate the data and plot a) The position –time graph b) the velocity-time graph. Repeat this for two different liquids and two different radii and compare the result.

5. Write and execute a program to draw graphs for radioactive disintegrations with different decay rates for different substances. Also calculate the half life's in each case.

6. Write a program to study the generation of the standing wave. Obtain the standing wave pattern for two different displacements and two different wave lengths.

7. Study the variation in phase relation between applied voltage and current of a series LCR circuit with three different set of values of L and C. Find the resonant frequencies and values of maximum current in each case (Use arbitrary source voltage and frequency).

8. Write and execute a C++ program to draw the phase plots for the following systems.(i) A conservative case (Simple pendulum) (ii) A dissipative case (Damped pendulum). (iii) A forced case. Repeat the experiment for another set of initial values.

9. Write and execute a C++ program to visualize the type of polarization of the electric field vector of an electromagnetic wave emerging from a polarizer. Repeat the programme for different phase differences.

10. Write and execute a program to draw the electric field due to a single charge kept at the centre of a screen.

11. Solve the given set of linear equation using Gauss elimination technique. Repeat the calculation for another set of linear equations.

12. Write and execute a C++ program to solve the given nonlinear equation by Bisection method. Repeat the calculation by changing the number of steps of calculations and observe the variation in result. Repeat the experiment for another equation.

13. Write and execute a program to evaluate an integral using Simpson's 1/3 rule 3/8 rule. Evaluate two different integrals, each using three different step sizes. Tabulate and compare the results for the different step sizes.

14. Write and execute a programme to solve a nonlinear equation using Bisection method. Obtain at least two roots of the equations
(1) $x^3-2x^2+x=0$ and (2) $2x^3-8x-18=0$ to an accuracy of 10^{-3}.

15. Write and execute a program for the numerical integration of the function $f(x) = 5+6x+7x^2+8x^3$ using Rectangle rule between limits x=2 and x=5.

16. Write a program and execute to find out how much of radium (half life 1620 years) and Berkelium (half life 1380 years) and Carbon -14 (half life 5730 years) will be left after 10,000 years if initial masses are 1 g each.

SEMESTER - IV

PHY4AMP ATOMIC AND MOLECULAR PHYSICS

Unit I

Atomic Spectra (18 Hrs)

The hydrogen atom and the three quantum numbers *n*, *l* and m_l. - electron spin - spectroscopic terms. Spin-orbit interaction, derivation of spin-orbit interaction energy, fine structure in sodium atom, selection rules. Lande g-factor, normal and anomalous Zeeman effects, Paschen–Back effect and Stark effect in one electron system. L S and j j coupling schemes (vector diagram) - examples, derivation of interaction energy, Hund's rule, Lande interval rule. Hyperfine structure and width of spectral lines.(qualitative ideas only).

Text Book:

1. Spectroscopy, B.P. Straughan & S. Walker, Vol. 1, John Wiley & Sons

Unit II

Microwave and Infra Red Spectroscopy (18 Hrs)

Microwave Spectroscopy: Rotational spectra of diatomic molecules - intensity of spectral
lines - effect of isotopic substitution. Non–rigid rotor - rotational spectra of polyatomic molecules - linear and symmetric top - Interpretation of rotational spectra.

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

Text Books:

1. Fundamentals of molecular spectroscopy, C.N. Banwell, Tata McGraw Hill
2. Molecular structure and spectroscopy, G. Aruldhas, PHI Learning Pvt. Ltd.

Unit III

Raman and Electronic Spectroscopy. (18 Hrs)

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

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

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

Text books:

1. Fundamentals of molecular spectroscopy, C.N. Banwell, MGH
2. Molecular structure and spectroscopy, G. Aruldhas, PHI Learning Pvt. Ltd.
3. Lasers and Non-Linear Optics, B.B Laud, Wiley Eastern

Unit IV

Spin Resonance Spectroscopy (18 Hrs)

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

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

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

Text Book:

1. Molecular structure and spectroscopy, G. Aruldhas, PHI Learning Pvt. Ltd.
2. Spectroscopy, B.P. Straughan & S. Walker, Vol. 1, John Wiley & Sons

Reference Books:

1. Introduction of Atomic Spectra, H.E. White, Mc Graw Hill
2. Spectroscopy (Vol. 2 & 3), B.P. Straughan & S. Walker, Science 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. Molecular Spectra and Molecular Structure, Vol. 1, 2 & 3. G. Herzberg, Van Nostard, London.
6. Elements of Spectroscopy, Gupta, Kumar & Sharma, Pragathi Prakshan
7. The Infra Red Spectra of Complex Molecules, L.J. Bellamy, Chapman & Hall. Vol. 1 & 2.
8. Laser Spectroscopy techniques and applications, E.R. Menzel, CRC Press, India

BLUE PRINT
IV SEM M.Sc
PHY4AMP- ATOMIC & MOLECULAR PHYSICS

Module		**Hours**	**Weight**			**Total Weight**
			1	**2**	**4**	**30**
			6 / 10	**4 / 6**	**4/8**	**30/54**
I	Atomic Spectra	18	3	1	2	13
II	Microwave Spectroscopy	18	2		1	13
	Infra Red Spectroscopy		1	1	1	
III	Raman Spectroscopy	18	1	1	1	14
	Electronic Spectroscopy		1	1	1	
IV	NMR	18	1		1	14
	ESR		1	1		
	Mossbauer Spectroscopy			1	1	

Questions from all the units of the syllabus shall be included in Parts A, B and C of the question paper. In Part A, a minimum of two questions must be asked from each unit. In part B, a minimum of one question has to be there from each unit. But there should not be more than two questions from a unit in Part B. In Part C, one question with internal choice from each Unit is to be included.

St. Teresa's College (Autonomous), Ernakulam
Fourth Semester M. Sc. Physics Degree Examination
PHY4AMP – ATOMIC & MOLECULAR PHYSICS
Model Question Paper

Time: 3 Hours **Maximum Weight : 30**

PART A

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

1. What is meant by quantum state of an atom? Illustrate with an example.
2. State Lande's Interval Rule.
3. Write the expression for Lande's g factor and explain the terms.
4. Outline the effect of isotopic substitution on the rotational spectra of molecules.
5. Point out the differences between infrared and microwave spectroscopy.
6. Homonuclear diatomic molecules do not show vibration spectra .Why?
7. Explain Rule of Mutual exclusion principle.
8. What is meant by predissociation.
9. Mention four applications of NMR.
10. What is meant by relaxation process?

(6 x 1 = 6)

Part B

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

11. Derive the expression for spin orbit interaction energy.
12. The frequencies of vibration of the following molecules are HCl: 2885 cm^{-1}; D_2:2990 cm^{-1}; DCl: 1990 cm^{-1}; and HD:3627 cm^{-1}. Calculate the energy change of the reaction
$$HCl + D_2 \longrightarrow DCl + HD$$
13. With which type of spectroscopy would one observe the pure rotation spectrum of H_2? If the bond length of H2 is 0.07417 nm, what would be the spacings of the lines in the spectrum?
14. State and explain Franck – Condon principle
15. Explain hyperfine structure of ESR spectrum and draw hyperfine structure of tritium.
16. Calculate the Doppler velocity corresponding to the natural line width of the γ ray emission from 14.4 keV excited state of ^{57}Fe nucleus having a half life of 9.8×10^{-8} s.

(4 x 2 =8)

PART C

III. Answer ALL questions.(Each question carries a weight of 4)

17. a) Explain coupling schemes. Derive the spectral terms for pd electrons using LS coupling.

OR

b) With necessary theory, explain Stark effect and draw stark pattern of hydrogen atom.

18. a) Explain the rotational levels and spectra of a non rigid rotator.

OR

b) Explain how the study of vibrational spectrum of a diatomic molecule enables us to determine the anharmonicity constant and equilibrium frequency of vibration.

19. a) Discuss the Raman activity of vibrations of CO_2 molecule.

OR

b) Explain rotational fine structure of electronic- vibrational transition.

20. a) Derive Bloch equations and arrive at the steady state solutions.

OR

b) Give an account of various applications of Mossbauer spectroscopy.

(4 x 4 = 16)

PHY4NPP NUCLEAR AND PARTICLE PHYSICS

Unit I

Nuclear Properties and Force between Nucleons (18 Hrs)

Nuclear radius, mass and abundance of nuclides, nuclear binding energy, nuclear angular momentum and parity, nuclear electromagnetic moments, nuclear excited states

Duetron, nucleon-nucleon scattering, proton-proton and neutron-neutron interactions, properties of nuclear forces, exchange force model

Text Book:

1. Introductory Nuclear Physics, K. S. Krane Wiley, (Chapter 3&4)

Unit II

Nuclear Decay and Nuclear Reactions (18 Hrs)

Beta decay, energy release, Fermi theory, experimental tests, angular momentum and parity selection rules, Comparative half lives and forbidden decays, neutrino physics, non conservation of parity

Types of reactions and conservation laws, energetics of nuclear reactions, isospin, Reaction cross sections, Coulomb scattering, nuclear scattering, scattering and reaction cross sections, compound-nucleus reactions, direct reactions, heavy ion reactions.

Text Book:

1. Introductory Nuclear Physics, K. S. Krane Wiley, (Chapter 9&11)

Unit III

Nuclear Models, Fission and Fusion (18 Hrs)

Shell model potential, Spin-orbit potential, Magnetic dipole moments, Electric quadrupole moments, Valence Nucleons, Collective structure, Nuclear vibrations, Nuclear rotations, Liquid drop Model, Semi-empirical Mass formula

Characteristics of fission - energy in fission - fission and nuclear structure, Controlled fission reactions - Fission reactors.

Fusion processes, Characteristics of fusion, Controlled fusion reactors Text Book:

1. Introductory Nuclear Physics, K. S. Krane Wiley, (Chapter 5, 13 &14)

Unit IV

Particle Physics (18 Hrs)

Types of interactions between elementary particles, Hadrons and leptons-masses, spin, parity and decay structure. Quark model, confined quarks, coloured quarks, experimental evidences for quark model, quark-gluon interaction. Gell-Mann-Nishijima formula, symmetries and conservation laws, C, P and T invariance, applications of symmetry arguments to particle reactions, parity non-conservation in weak interactions. Grand unified theories.

Text Book:

1.Introductory Nuclear Physics, K. S. Krane Wiley, (Chapter 18)

2. Nuclear Physics, D. C. Tayal, Himalaya Publishing House (Chapter 16)

Reference Books:

1. Introduction to Elementary Particle, D.J. Griffiths, Harper and Row, NY,(1987)
2. Nuclear Physics, R.R. Roy and B.P. Nigam, New Age International, NewDelhi, (1983).
3. The particle Hunters - Yuval Ne'eman & Yoram kirsh CUP, (1996)
4. Concepts of Nuclear Physics, B.L. Cohen, TMH, New Delhi, (1971).
5. Theory of Nuclear Structure, M.K. Pal, East-West, Chennai, (1982).
6. Atomic Nucleus, R.D. Evans, McGraw-Hill, New York.
7. Nuclear Physics, I. Kaplan, 2nd Edn, Narosa, New Delhi, (1989).
8. Introduction to Nuclear Physics, H.A. Enge, Addison Wesley, London, (1975).
9. Introductory Nuclear Physics, Y.R. Waghmare,Oxford-IBH, New Delhi, (1981).
10. Atomic and Nuclear Physics, Ghoshal,Vol. 2, S. Chand & Company
11. Fundamentals of Elementary Particle Physics, J.M. Longo, MGH, New York, (1971).
12. Nuclear and Particle Physics, W.E. Burcham and M. Jobes, Addison-Wesley, Tokyo, (1995).
13. Subatomic Physics, Frauenfelder and Henley, Prentice-Hall.
14. Particles and Nuclei: An Introduction to Physical Concepts, B. Povh, K. Rith, C. Scholz and Zetche, Springer (2002)
15. Elementary Particles and Symmetries, L.H. Ryder, Gordon and Breach, Science Publishers, NY, 1986

Blue Print

M. Sc. Physics (IV Semester)

PHY4NPP - NUCLEAR AND PARTICLE PHYSICS

Units	Hours	1 Weight 6/10	2 Weight 4/6	4 Weight 4/8	Total Weight 30/54
Unit I	18	3	1	2	13
Unit II	18	2	2	2	14
Unit III	18	2	2	2	14
Unit IV	18	3	1	2	13

Questions from all the units of the syllabus shall be included in Parts A, B and C of the question paper. In Part A, a minimum of two questions must be asked from each unit. In part B, a minimum of one question has to be there from each unit. But there should not be more than two questions from a unit in Part B. In Part C, one question with internal choice from each Unit is to be included.

St. Teresa's College (Autonomous), Ernakulam
Fourth Semester M. Sc. Physics Degree Examination
PHY4NPP - NUCLEAR AND PARTICLE PHYSICS

Model Question Paper

Time: 3 hours **Total weight: 30**

Part A

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

1. Find the radius of $_6C^{12}$ nucleus.
2. Calculate the binding energy difference for the mirror nuclei $_8O^{15}$ and $_7N^{14}$.
3. Give any four properties of nuclear forces.
4. What is Kurie plot?
5. Write selection rules for allowed decay? Give one example.
6. What are the basic assumptions of liquid drop model?
7. Mention any three characteristics of fusion.
8. State and explain CPT theorem.
9. Explain the need for colour quantum number in describing quarks.
10. Briefly explain Grand Unified Theory(GUT).

(6 x 1 = 6)

Part B

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

11. If the binding energy of B of a nucleus with mass no A and charge Z is given by

$$B = a_v A - a_s A^{2/3} - a_{sym}\frac{(2Z-A)^2}{A} - a_c \frac{Z^2}{A^{1/3}}$$

Where a_v = 16 MeV, a_s = 16 MeV, a_{sym} = 24 MeV and $a_c =$ 0.75 MeV, then find the Z value for the most stable isobar for a nucleus with A= 216.

12. Compute the Q value for the following β- decays
    a. $^{65}Ni \rightarrow {}^{65}Cu$
    b. $^{11}Be \rightarrow {}^{11}B$
    c. $^{193}Os \rightarrow {}^{193}Ir$

13. Classify the following decays according to the degree of forbiddeness.
    a. $^{89}Sr\ (5/2^+) \rightarrow {}^{89}Y\ (1/2^-)$
    b. $^{36}Cl\ (2^+) \rightarrow {}^{36}Ar\ (0^+)$
    c. $^{26}Al\ (5^+) \rightarrow {}^{26}Mg\ (2^+)$
14. Derive the condition for a nucleus to be stable against symmetric fission.
15. Obtain the ground state spins and parities of the following nuclei and explain the reason.
16. Which of the following reactions are allowed and forbidden through strong interaction? Give reason.

    a) $K + p \rightarrow \Lambda^0 + \pi^- + \pi^+$

    b) $\pi^+ + n \rightarrow K^+ + \Sigma^0$

    c) $\Xi^- \rightarrow \Sigma^- + \pi^0$

(4 x 2 = 8)

Part C

III. Answer ALL questions.(Each question carries a weight of 4)

17 (a). Discuss the partial wave analysis of n-p scattering.

OR

(b). Discuss the exchange force model and the Yukawa meson theory of nuclear forces.

18 (a). Give an account of Fermi theory of β decay.

OR

(b). Discuss the non conservation of parity in β decays.

19 (a). Discuss the Shell model of nucleus and explain how the introduction of spin- orbit

interaction account for the magic numbers.

OR

(b). With a schematic diagram discuss a nuclear fission reactor.

20 (a). Distinguish between hadrons and leptons. Give an account of the interaction between elementary particles.

OR

(b). Explain the quark model for nuclear forces.

(4 x 4 = 16)

3.3 ELECTIVES

3.3.1 BUNCH – A: ELECTRONICS

PHY3IED: INTEGRATED ELECTRONICS AND DIGITAL SIGNAL PROCESSING

Unit I

Integrated Circuit Fabrication and Characteristics (16 Hrs)

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

Unit II

Basics of Digital Signal Processing (18 Hours)

Signals and representation – classification - continuous time (CT) and discrete time (DT) signals - standard CT and DT signals - Fourier Analysis of periodic and aperiodic continuous time signals - convolution and correlation of DT and CT Signals – classification of systems CT – DT - causal, noncausal, static and dynamic systems - stable systems - FIR and IIR systems -frequency domain representation of systems

Unit III

DSP Techniques (18 Hrs)

Frequency analysis of DT signals - discrete Fourier Transform - Fast Fourier

Transform (FFT) - Decimation in time and decimation in frequency algorithm - Z-Transform regional convergence and properties - relation to Fourier Transform - Poles and Zeros of system function - Gibb's phenomenon

Unit IV

Digital Filters (20 Hrs)

FIR and IIR Filters - IIR Filter design techniques - Approximation of derivatives - Impulse invariant method - Bilinear transformation - FIR filter design techniques - Fourier Series method - Window techniques - FIR filter using rectangular window - Realisation of IIR systems - Direct form I & form II realization - Direct form and cascade form realization of FIR systems - Finite word length affecting digital signal processing.

Text Books

1. Integrated Electronics – Analog and Digital Circuits and Systems, J. Millmann & C.C. Halkias, TMGH
2. Digital Signal Processing: Theor, Analysis and Digital-Filter Design, B. Somanathan Nair, PHI (2004)
3. Digital Signal Processing, P. Ramesh Babu, Scitech
4. Digital Signal Processing, Alan V. Oppenheim & R.W. Schafer, PHI

Reference Books:

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

BLUE PRINT

PHY3IED - INTEGRATED ELECTRONICS & DIGITAL SIGNAL PROCESSING

Unit	**Hours**	**Weightage 1**	**Weightage 2**	**Weightage 4**	**Total Weightage 30**
		6 / 10	**4 / 6**	**4/8**	**30/54**
I IC fabrication & DSP	16	2	1	2	12
II Basics of DSP	18	3	1	2	13
III DSP Techniques	18	2	2	2	14
IV Digital Filters	20	3	2	2	15

Questions from all the units of the syllabus shall be included in Parts A, B and C of the question paper. In Part A, a minimum of two questions must be asked from each unit. In part B, a minimum of one question has to be there from each unit. But there should not be more than two questions from a unit in Part B. In Part C, one question with internal choice from each Unit is to be included.

St. Teresa's College (Autonomous), Ernakulam
Third Semester M. Sc. Physics Degree Examination
PHY3IED - INTEGRATED ELECTRONICS & DIGITAL SIGNAL PROCESSING

Time: 3 Hours **Maximum Weight : 30**

PART A

I. Answer any *SIX* questions. Each question carries a weight of 1

1. Explain why most of the monolithic transistors are of npn type?
2. Describe the usefulness of an n^+ layer wherever aluminium metallization is required in integrated circuit components?
3. Distinguish between CT and DT exponential signals.
4. Explain briefly the time scaling operation on DT signals.
5. Determine the convolution sum of two sequences $x_1(n) = \{2,1,5,9\}$ and $x_2(n) = \{3,2,7,4\}$.
6. What is the advantage of FFT over DFT.
7. Where the Z transform converges to Fourier transform?
8. Compare FIR and IIR filters.
9. Explain Gibbs phenomenon.
10. Explain briefly the window technique.

(6 x 1 = 6)

Part B

II. Answer any *FOUR* questions. Each question carries a weight of 2

11. Describe the diffusion equation and explain the nature of the diffusion curves for gaseous and solid impurity states.
12. Check whether the system described by the equation $y(n) = x(n) + \frac{1}{x^2(n-1)}$ linear and non linear and time variant or time invariant.
13. Find the DFT of a sequence { 1, 3, 5, 4, 1, 8, 3, 2 } using DIT algorithm.
14. Compute the N point DFT of the following sequences (i) $x(n) = \delta(n)$ (ii) $x(n) = a^n$.
15. Explain direct and cascade form realization of FIR filters.
16. Describe the finite word length effect in DSP.

(4 x 2 =8)

PART C

III. Answer ALL questions. Each question carries a weight of 4

17. a) Explain the steps involved in the fabrication of integrated circuits?

OR

b) How is an Aluminium contact made with n type silicon so that it is a) ohmic and b) rectifying? Also explain how storage time is eliminated in a metal-semiconductor diode?

18. a) Discuss different types of standard DT and CT signals. Also discuss the classification of signals according to its energy and power with examples.

OR

b) Explain representation of CT aperiodic signal in frequency domain. Discuss its properties.

19. a) Explain the techniques used in decimation in frequency method of FFT.

OR

b) Define the Z transform of a sequence x(n). Discuss its properties. Also find the Z transform of the following sequences (i) $a^n U(n)$ (ii) $\delta(n-2) + \delta(n-1) + \delta(n)$ (iii) { 1, 5, 1, 2, 8 } with pole – zero plot.
↑

20. a) Discuss impulse invariant and bilinear transformation methods in IIR filter design.

OR

b) Discuss linear FIR filter design.

(4 x 4 = 16)

PHY3MES MICROELECTRONICS AND SEMICONDUCTOR DEVICES

Unit I

Basics of Digital Techniques (18 Hrs)

Review of 8085 microprocessor - General organization of a microprocessor based microcomputer system – memory organization – main memory array –

memory management – cache memory – virtual memory - input/output - standard I/O – memory mapped I/O – microcomputer I/O circuits – interrupt driven I/O –DMA – RAM - hard disk - CD – Flash memory.

Unit II

8086 Microprocessor (19 Hrs)

The Intel 8086 - architecture - MN/MX modes - 8086 addressing modes - instruction set- instruction format - assembler directives and operators - Programming with 8086 - interfacing memory and I/O ports - Comparison of 8086 and 8088 - Coprocessors - Intel 8087 - Familiarisation with Debug utility.

Unit III

Microcontrollers (19 Hrs)

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

Unit IV

Semiconductor Devices (16 hrs)

Schottky barrier diode - qualitative characteristics – ideal junction properties – nonlinear effects on barrier height – current voltage relationship – comparison with junction diode – metal semiconductor ohmic contact – ideal non rectifying barriers – tunnelling barrier – specific contact resistances – hetro-junctions – hetro junction materials – energy band diagram – two dimensional electron gas – equilibrium electrostatics – current voltage characteristics

Text Books

1. Microprocessors and Microcomputer based system design, H.

Rafiquizzaman, Universal Book stall, New Delhi

2. Microprocessor and Peripherals, S.P. Chowdhury & S. Chowdhury-SCITECH Publications
3. Microprocessor Architecture Programming and Applications with 8085, R.S. Gaonkar – Penram int. Pub. Mumbai
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

Reference Books:

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

Blue Print
M.Sc Physics III Semester
PHY3MES Microelectronics and Semiconductor Devices

Units	**Hours**	**1 Weights 6/10**	**2 Weights 4/6**	**4 Weights 4/8**	**Total Weights 30/54**
Unit I	18	2	1	2	12
Unit II	19	3	2	2	15
Unit III	19	3	2	2	15
Unit IV	16	2	1	2	12

Questions from all the units of the syllabus shall be included in Parts A, B and C of the question paper. In Part A, a minimum of two questions must be asked from each unit. In part B, a minimum of one question has to be there from each unit. But there should not be more than two questions from a unit in Part B. In Part C, one question with internal choice from each Unit is to be included.

St. Teresa's College (Autonomous), Ernakulam
Third Semester M. Sc. Physics Degree Examination
PHY3MES-MICROELECTRONICS AND SEMICONDUCTOR DEVICES
Model Question Paper

Time: Three Hours **Maximum Weight: 30**

Part A

(Answer any **six** questions, each carries weight 1)

1. Briefly explain DMA.
2. Write a short note on interrupt driven I/O.
3. Briefly explain the assembler directives of 8086 microprocessor.
4. Compare the features of 8086 and 8088 microprocessors.
5. Write an account of flag registers in 8086 microprocessor.
6. Briefly discuss the counter and timers in 8051 microcontroller.
7. Give a comparison between microcontroller and microcontroller.
8. Write a short note on debug utility.
9. Briefly explain hetero–junctions.
10. Draw and briefly explain energy band diagram.

(6 x 1 = 6)

Part B

(Answer any **four** questions, each carries weight 2)

11. Differentiate standard I/O and memory mapped I/O.
12. Write an 8086 assembly language program to clear 100_{10} consecutive bytes.
13. Explain the features of coprocessor.
14. Compare microprocessor and microcontroller. Write the applications of microcontroller.
15. Write an account of interrupts in 8051 microcontroller.
16. Discuss metal semiconductor ohmic contact.

(4 x 2 = 8)

Part C

(Answer **all** questions, each carries weight 4)

17. (a) Explain the organization of microprocessor based microcomputer system.

OR

(b) Discuss the memory organization of microprocessor.

18. (a) Give an account of various addressing modes in 8086 microprocessor.

OR

(b) Sketch and explain the architecture of 8086 microprocessor.

19. (a) Sketch and explain the pin out diagram of 8051 microcontroller.

OR

(b) Explain the register sets of 8051 microcontroller.

20. (a) Discuss two dimensional electron gas.

OR

(b) Explain schottky barrier diode.

(4 x 4 = 16)

PHY4ICE INSTRUMENTATION AND COMMUNICATION ELECTRONICS

Unit I

Transducers and Digital Instrumentation (20 Hrs)

Transducers: Classification of transducers - electrical transducer - resistive transducer - strain gauges- piezo-electric and magnetostrictive transducers - Hall effect transducers -thermistor inductive transducer - differential output transducers - pressure transducers - pressure cell - photoelectric transducers - photo voltaic cell – semi conductor photo diode – thermo electric transducers

– mechanical transducers – ionization transducers – digital transducers - electro chemical transducers.

Digital Instrumentation: Digital counters and timers - digital voltmeter – RAMP - voltage to time conversion - voltage to frequency conversion - frequency to voltage conversion - digital multimeter - digital phase meter -

digital frequency meter - time and frequency measurement – tachometer - pH meter.

Unit II

Measurement of Basic Parameters and Recorders (18 Hrs)

Transistor Voltmeter - amplified DC meter – A.C voltmeters using rectifiers – precision rectifier – true RMS responding voltmeter – chopper type DC amplifier voltmeter - milli voltmeter using operational amplifier – differential voltmeter – Ohm meter – electronic multimeter – commercial multimeter – output power meters - stroboscope – phase meter – vector impedance meter – Q meter – RF measurement – transistor testers – CRO (Basic ideas)

Recorders: Strip chart recorders - XY recorders - digital XY plotters - magnetic recorders -digital data recording - Storage oscilloscope – Digital storage oscilloscope

Unit III

Introduction to Communication (18 Hrs)

Bandwidth requirements − SSB technique – radio wave propagation − Ionosphere − Ionosphere variations − Space waves − Extraterrestrial communication - Transmission lines − Basic principles − Characteristic impedance − Losses − Standing waves − Quarter and half wavelength lines.

Television fundamentals − Monochrome transmission − Scanning − Composite TV video wave form − Monochrome reception – Deflection circuits − Colour Television. Basic ideas of high definition TV – LCD & LED TV

Unit IV

Digital Communication (16 hrs)

Pulse Communication – Information theory – Coding – Noise – Pulse modulation – PAM – PTM – PCM – PPM. Digital communication – Data Communication – Digital codes – Data Sets and interconnection requirements.

Multiplexing techniques – Frequency division and time division multiplexing. Microwave generators – Klystron and Magnetron – Satellite communication. Digital cellular systems GSM, TDMA and CDMA – basic ideas of GPS

Text Books:

3. Electronic Instrumentation, H.S. Kalsi, TMH (1995)
4. Transducers and instrumentation, D.V.S. Murty, PHI (1995)
5. Monochrome and Colour Television R.R. Gulati, New Age India
6. Electronic communication systems, George Kennedy, TMH
7. Mobile Cellular Telecommunication Systems, William C.Y. Lee, MGH

Reference Books:

1. Modern electronic Instrumentation and Measurement Techniques, A.D. Helfric & W.D. Cooper,PHI, (1997)
2. Instrumentation-Devices and Systems 2nd Edn. C.S. Rangan, G.R. Sarma, V.S.V. Mani, TMH, (1998)
3. Electronic Measurements and Instrumentation, M.B. Olive & J.M. Cage, MGH, (1975)
4. Digital Instrumentation, A.J. Bouwens,TMH, (1998)
5. Elements of Electronic Instrumentation, J. Jha, M. Puri, K.R. Sukesh, & M.Kovar., Narosa, (1996)
6. Instrumentation Measurement and Analysis, B.C. Nakra & K.K. Chaudhry, TMH, (1998)
7. Op-amps and Linear Integrated Circuits, R.A. Gaykward, PHI, (1989)
8. Electronic fundamentals and Applications, John D. Ryder, PHI.
9. Satellite communication, Robert M.Gagliardi, CBS Publishers, Delhi.
10. Electric and electronic measurements and instrumentation 10th Edn. A.K. Sawhney, Dhanpath Rai & Company.

Blue Print

M.Sc IV Semester

PHY4ICE INSTRUMENTATION AND COMMUNICATION ELECTRONICS

Units	Hours	1 Weight 6/10	2 Weight 4/6	4 Weight 4/8	Total Weight 30/54
Unit I	20	3	2	2	15
Unit II	18	2	2	2	12
Unit III	18	3	1	2	15
Unit IV	16	2	1	2	12

Questions from all the units of the syllabus shall be included in Parts A, B and C of the question paper. In Part A, a minimum of two questions must be asked from each unit. In part B, a minimum of one question has to be there from each unit. But there should not be more than two questions from a unit in Part B. In Part C, one question with internal choice from each Unit is to be included.

St. Teresa's College (Autonomous), Ernakulam
Fourth Semester M. Sc. Physics Degree Examination
PHY4ICE – INSTRUMENTATION AND COMMUNICATION ELECTRONICS

Model Question Paper

Time: Three Hours **Maximum Weight: 30**

Part A

I. Answer any *SIX* of the following questions. (Each question carries a weight of 1)

1. Describe the principle of working of Hall effect transducers.
2. Explain any two uses of a capacitive transducer.
3. Comment on tachometer.
4. What is the function of a sweep generator in CRO?
5. Write a short note on magnetic recorders.
6. Explain the basic principle involved in differential voltmeter.
7. Explain what is meant by the Y, I & Q signals in color TV.
8. Briefly describe standing waves.
9. What are the advantages of Pulse Code Modulation?
10. Write down the difference between TDMA & CDMA.

(6 x 1 = 6)

Part B

II. Answer any *FOUR* of the following questions. (Each question carries a weight of 2)

11. Describe the working of a linear variable differential transducer.
12. Briefly explain bonded and unbonded strain gauges.
13. Write down the principle and working of a Q-meter.
14. Explain the working of a chopper type DC amplifier voltmeter.
15. Explain vestigial side band transmission.

16.How pulse modulation is different from frequency modulation and amplitude modulation? (4 x 2 = 8)

Part C

III. Answer *ALL* the following questions. (Each question each carries a weight of 4)

17(a). Define a digital transducer and explain its application for measurement of linear and angular displacements.

Or

(b). Write the difference between digital counters and timers.

18(a). Explain the working and use of a true RMS responding voltmeter with block diagram.

Distinguish it from AC voltmeter.

Or

(b). Give the block diagram of a digital storage oscilloscope. Explain its working.

19(a). Explain the SSB generation using a balanced modulator.

Or

(b). Draw the block diagram of a monochrome TV transmitter and explain the function of each block.

20(a). Explain the principle of pulse width modulation. With the help of a circuit explain the generation of PWM.

Or

(b). Write about the multiplexing techniques for communication.

(4 x 4 = 16)

PHY4AE(P) ADVANCED ELECTRONICS PRACTICALS

(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. Multichannel 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.

[B] Communication Electronics

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

[C] Electronic Instrumentation

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

[D] Optoelectronics

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

ST. TERESA'S COLLEGE, ERNAKULAM (AUTONOMOUS)

M. Sc. DEGREE (P.G.C.S.S) PRACTICAL EXAMINATION

M. Sc. PHYSICS – SECOND YEAR

PHY4AE(P) Advanced Electronics Practicals

Time: 5 Hours **Maximum weight: 30**

Instructions:

22. *Write the register number on the top of the additional sheet.*
23. *Copy the question marked X into the additional sheet.*
24. *No change in questions shall be allowed.*
25. *Write a brief procedure for the above question with necessary principle, formula with symbols explained, design of circuits, pattern of graphs etc. .*
26. *Return the additional sheet within 30 minutes.*
27. *Start doing the experiment after filling the details such as your register number in the main sheet*
28. *Ensures that examiners have checked your reading before you wind up the experiment.* ***Record your observations in ink.***
29. *Write the units of the quantities in the top row of tabular column.*
30. *Show neatly the substitutions and calculations.*
31. *After completing the experiment, write the result with unit.*
32. *For Microprocessor and Microcontroller experiments, candidates should write either algorithm or flow chart. Candidates can use either a PC or 8086 microprocessor kit.*

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15. Write a program to find the largest and smallest of numbers in an array of memory and store the result in a given memory location. Modify the program to find the smallest of the numbers in the array of memory.

16. Write a program to convert a Hexadecimal number to its ASCII Hexcode equivalent and also convert ASCII to Hexadecimal numbers. Store the result in a given memory location.

17. Write a program to convert a Decimal number to its ASCII equivalent and also convert ASCII to decimal numbers. Store the result in a given memory location.

18. With necessary circuit diagram and theory, construct an electronic device to demonstrate a pulse amplitude modulation.

19. Design and construct a Amplitude modulator and demodulator and study the modulation index for different modulating signals.

20. Design and construct a frequency modulator and demodulator and study the modulation index for different modulating signals.

21. Construct an instrumentation amplifier using a transducer. Study the variation of the output voltage as a function of a suitable energy parameter.

22. With necessary circuit diagram and theory construct a DC millivoltmeters. Check the accuracy and hence draw the calibration graph.

23. With necessary circuit diagram and theory construct a AC millivoltmeters. Check the accuracy and hence draw the calibration graph.

24. Construct a voltage to frequency converter with a maximum output of 10 kHz and study the output frequency as a function of input voltage. Modify the circuit to increase the output voltage to 30 kHz.

25. Construct a frequency to voltage converter and study the output voltage as a function of the input frequencies. Repeat the experiment for both the sine and square wave input.

26. With necessary principle, measure the beam profile and beam spot size of a laser beam. Also calculate the beam divergence.

27. Determine the temperature coefficient of resistance of copper.

3.3.2 BUNCH – B: INFORMATICS

PHY3DCI DATA COMMUNICATION AND INTERNET WORKING

Unit I

Data Communication (18 Hrs)

Data Communication Terminology – Channel-Baud-Bandwidth-Frequency. Modes of data transmission – Serial and Parallel - Synchronous, Asynchronous & Isochronous Communications - Analog & Digital Data Transmission - Transmission impairments – Attenuation-Delay Distortion-Noise- Concept of Delays. Transmission Media and its Characteristics – Magnetic media-Twisted pair-Base band coaxial cable - Broadband Coaxial cable - Optical Fiber -Comparison between optical fiber and copper wire - Wireless transmission – Microwave Transmission - Radio Transmission - Infrared and millimeter waves - Wireless LAN

Unit II

Data Communication (cont..) (18 Hrs)

Multiplexing (FDM, TDM) – Switching paradigms (circuit, packet and cell switching) – propagation delay – clock synchronization.

Network access control (Centralized, decentralized, distributed) – Overview of satellite communication – Fourier series & transforms and their applications to data communication.

Unit III

Computer Networks (18 Hrs)

Importance of Networks – Components of Networks - Classification of Networks – Broad cast networks - Switched networks - Switching Techniques - Types of Networks – LAN – MAN – WAN.

Networking Models – OSI reference model – TCP/IP reference model - Network Topology – Bus-Star-Ring-Tree-Mesh-Cellular - Network Architecture – Client/Server, Peer-to-Peer

Unit IV

The Internet (18 Hrs)

Internet Protocols – Internet Protocol (IP)-Transmission Control Protocol (TCP) - Internet Address – Structure of Internet Servers Address-Address Space - Internet Infrastructure - Services on Internet – Domain Name System-SMTP and Electronic mail – Http and World Wide Web-Usenet and News groups-FTP-Telnet - Network

Security – Ideas of secret key Algorithms and Public key Algorithms-Digital Signature-E-mail Privacy - Internet Tools – Search Engines-Web browsers

Text Books

1. Data and Computer communication, William Staling, 7th Edn. PHI
2. Computer Networks, A.S. Tanenbaum, PHI
3. Internet and World Wide Web, Harvey M. Deitel, PHI
4. Computer Network, Behrouz. A. Forouzan, Sophia Chung Fegan, MGH.

Reference Books:

1. Data communication - Reid and Bartskor
2. Data networks, D.P. Bertsekas & R.G. Gallager, Pearson.
3. Communication networks, Alberto Leon – Gracia and IndraWidjaja, MGH, (2003)
4. Introduction to communication systems, Simon S. Haykins, Wiley
5. Analog and digital Communication, Simon S Haykins, Wiley
6. Computer Communications and Networking Technologies, Michal A. Gallo and William M. Hancock, Thomson Asia 2nd Reprint, 2002.
7. Networks, Tirothy S. Ramteke, 2nd Edn. Pearson Education , New Delhi, 2004

PHY3JLS JAVA AND LINUX OPERATING SYSTEM Unit I (18 Hrs)

Fundamentals of Object oriented programming, Java Evolution (basic Ideas only) **(2 hrs)**

Over view of Java language – constants, variables, and data types – Operators and expressions – Decision making and branching – decision making and looping. **(16 hrs)**

Text Book:

1. Programming With Java – A Primer, E. Balagurusamy 3rd Edn TMH. (Ch. 1,2,3,4,5,6,7)

Unit II (18 Hrs)

Classes, objects and methods – Arrays, strings and Vectors – interfaces – Packages

Text Book:

1. Programming With Java– A Primer, E. Balagurusamy 3rd Edn. TMH. (Ch.8,9,10,11)

Unit III (18 Hrs)

Multithreaded programming – Managing errors and exceptions – Applet programming – Graphics programming

Text Book:

1. Programming With Java – A Primer, E. Balagurusamy 3rd Edn TMH. (Ch.12,13,14,15)

Unit IV

Linux Operating System (18 Hrs)

Features of Linux – Drawbacks of Linux - Components of Linux – Memory management sub system - Linux process and thread management - File management sub system - Device Drivers.

Linux Commands and Utilities – Entering the machine - The file system Linux Utilities and Editor – Useful Commands - Permission modes and Standard Files - Pipes. Filters and Redirection - Shell Scripts - Graphical User Interface-Editor

User to User Communication – Online Communication-Offline Communication - Apache Server Settings-Network Server settings - DNS,NFS

Popular applications in Linux (open office, python etc…) – Familiarization of Ubuntu

Text Books:

1. Linux Bible, Christopher Negus, John Wiley & Sons
2. Operating System: Linux – NIIT, Prentice Hall of India

Reference Books:

1. JAVA2, The Complete Reference, Herbert Schidlt, 4th Edn. TMH
2. Object Oriented Design in Java (Mitchell Waite Signature Series), S.Gilbert, B. Mccarty
3. Object Oriented Analysis and Design in Java, Grady Booch

4. http://java.sun.com
5. UNIX and LINUX, Goel, Ritendra, Jagdamba Publishing Company-2004
6. http://www.redhat.com/docs/manuals/linux
7. http://www.linux.org

PHY4CAP COMPUTER APPLICATIONS IN PHYSICS Unit I

Introduction to MATLAB (18 Hrs)

MATLAB environment – working with data sets – data input/output – logical variables and operators – array and X-Y Plotting – simple graphics – data types matrix, string, cell and structure – manipulating of data of different types – file input – output – matlab files – simple programs.

Unit II

MATLAB Tools (18 Hrs)

Signal processing – toolbox – digital and analog filter design – spectral analysis – filtering and discrete FFTs – Z-transform – DFT and FFT – MATLAB tools for wavelet transform – instrument control toolbox – partial differential equation toolbox – finite element method.

Unit III

Introduction to LABView (18 Hrs)

Introduction – palette, controls & functions palette – data types, conversion.
Front Panel: Construction, containers, decorations, vi properties, tabs – parallel data flow, create indicators/controls/constants indicators, controls – math operations, booleans, arrays, case structures, sequences – for loops, while loops, shift registers, clusters.

Unit IV

Interfacing with LABView (18 Hrs)

Error handling, bundle/unbundle sub VI'S - I/O: reading and writing to files, paths, data taking, charting, graphing timing function, timed loops, event structures signal generation/processing, waveform types, dynamic data, Fourier analysis – connecting to hardware – DAQ, Serial, GPIB, TCP/IP and USB interface.

Reference Books

1. Introduction to Matlab, R.L. Spencer & M. Ware, Brigham Young University (2010).
2. Learning MATLAB, The Math Works, Inc (1999).
3. Digital Signal Processing Using Matlab, V.K. Lngle & J.G. Proakis, PWS Publishing Company (1997).
4. Digital Image Processing Using MATLAB, R.C. Gonzalez, R.E. Woods, & S. L. Eddins, Prentice-Hall (2003).
5. LabVIEW Basics I Course Manual, National Instruments Corporation.
6. Electronics with LabVIEW, Kenneth L. Ashley, Analog Pearson Education (2003).
7. Applications of Numerical Techniques with C, Suresh Chandra, Narosa (2006).

PHY4IE(P) PRACTICALS - INFORMATICS ELECTIVE

1. (a) Write and execute a program to find the summed average of two numbers using inheritance.

   (b). Write and execute a program to multiply two numbers using polymorphism.

2. (a). Create an Interface having two methods – division and modulus. Create a class which overrides these methods.

   (b). Write a program in java to display the names and register numbers of students. Initialize the respective array variables for 10 students. Handle ArrayIndexOutOfBounds Exception so that any such problem doesn't cause illegal termination of program.

3. (a) Write a program for generating two threads, one for printing even numbers and the other for printing odd numbers.

   (b). Write a program to read a statement from console, convert it into upper case and again print on console.

4. Write a program to introduce a 'text filed' and 'text area' activated by three buttons.
5. Write a java applet program which reads your name and address in different text fields and when a button named find is pressed the sum of the length of characters in name and address is displayed in another text field. Use appropriate colors and layout to make your applet look good.
6. Write and execute a program in Java to display an ordinary working calculator on the screen.
7. Write and execute an applet in java to display the applet with following conditions.

   (a). There should be a menu with options LINE,RECTANGLE, CIRCLE, ELLIPSE and EXIT.

   (b). If the option ELLIPSE is selected and if the mouse is clicked and dragged, an ellipse with varying size should be displayed on the screen. (c). Suitable display should be generated when other options other than EXIT are selected.

   (d). When EXIT is selected the applet should exit from the screen.
8. Write and execute a program to display a round running clock.

Linux experiments for getting an idea of Linux only. You can do more.

9. Execute the following commands on your operating system and write down the results and use of each command.

   Man

   Cd

   ls, ls –a, ls -al cd. &

   cd.. pwd

   ls –al | more cat

   passwd chmod
10. Try to explore the file system, write what is there in /bin, /user/bin, /sbin, /tmp, and /boot. Find and list the devices that are available in your system.
11. Make your own directories, subdirectories in the root.
12. Create a file using the vi editor. Copy this file to other directories. Change the

permissions of your file.

13. Send a message to all the users.
14. Create a small text file and send it to another user.
15. Write a shell script to display a message on the screen.

16. Experiments using MATLAB/Python for physics applications
17. (a). Create a Web Page With appropriate content and insert an image towards the left hand side of the page. When the user clicks on the image it should open another web page.

    (b). Create a web page. When the user clicks on the link it should go to the bottom of the Page.
18. (a). Create a web page having two frames, one containing the links and when the links are clicked appropriate contents should be displayed in frame 2

    (b). Design a page with a text box called "name" and a button with label "enter". When you click on the button another page should open, with the message "welcome<name>" where the name should be equal to the name entered in the first page.
19. Design a single page web site for a university containing a description of the courses offered. It should also contain some general information about the university such as its history, the campus, and its unique features and so on. The site should be colored and each section should have a different color.
20. Make out a brief Bio – data of yours and code it as an HTML page. Use tables to show your academic history.
21. Create a web page showing your personal information using text boxes, radio buttons, check boxes, Select tag and Pull Down lists. The form should contain First name, Middle name, Last name, Date of Birth, Marital status, Gender, Pin code, Country, Education, Annual income, City, state, Occupation, Industry etc.
22. Create a web page having minimum of 4 pages with home page containing links

to other pages. Use maximum number of tags in the program.

23. Use internet with various Browsers & search engines, create your own E-mail address, try browsing for your syllabus portions and practice all the uses of the internet.
24. (a). Write a Java Script code block using arrays and generate the current date in words. This should include the day, the month and the year.]
    (b). Write a java script code that converts the entered text into upper case.
    (c). Write a program to display the multiplication table.
25. (a). Write a Java script code to accept radius and display the area of the circle.
    (b). Write a code to create a Scrolling text in a text box.
    (c). Write a program to change the colour of a text randomly.
26. Using Java script create a digital clock.
27. Create an HTML form that inputs student details and when submitted display the same on the HTML page.

3.3.3 BUNCH - C: MATERIAL SCIENCE

PHY3SSP SOLID STATE PHYSICS Unit I

Crystals and Symmetry Properties (20 Hrs)

Crystalline state – Anisotropy - Symmetry elements – Translational, Rotational, Reflection – Restrictions on Symmetry elements – Possible combinations of Rotational Symmetries- Crystal systems - 14 Bravais lattices.

Stereographic projection and point groups – principles – Constructions - Construction with the Wulff net - Macroscopic Symmetry elements-Orthorhombic system-Tetragonal system- Cubic system - Hexagonal system - Trigonal system - Monoclinic system- Triclinic system - Laue groups - Space groups.

Unit II

Optical Properties and Crystal Lasers (16 Hrs)

Lattice vacancies – diffusion – colour centres – F-centre and other centres in alkali halides – ionic conductivity – colour of crystals – excitons in molecular crystals – model of an ideal photoconductor – traps – space charge effects – experimental techniques – transit time excitation and emission Aicalf mechanism – model for thallium activated alkali halides - electroluminescence.

Lasers: Properties of laser beams - temporal coherence - spatial coherence – directionality – single mode operation - frequency stabilization - mode locking - Q-Switching - measurement of distance - Ruby laser - four-level solid state lasers - semiconductor lasers - Neodymium lasers (Nd:YAG, Nd:Glass) .

Unit III

Semiconductor crystals (18 Hrs)

Classification of materials as semiconductors - band Gap - band structure of Silicon and germanium - equations of motion - intrinsic carrier concentration - impurity conductivity- Thermoelectric effects in semiconductors – semimetals - amorphous semiconductors - p-n junctions.

Plasmons, Polaritons and Polarons: Dielectric function of the electron gas – plasmons - electrostatic screening- **p**olaritons and the LST relation – electron - electron interaction - Fermi liquid - electron-phonon interaction - Polarons- Peierls instability of linear metals.

Unit IV

Imperfections and Dislocations (18 Hrs)

Types of imperfections in crystals - thermodynamic theory of atomic imperfections – experimental proof – diffusion mechanisms - atomic diffusion theory – experimental determination of diffusion constant – ionic conduction – shear strength of single crystals - slip and plastic deformations. Dislocations - Burgers vectors – edge and screw dislocations – motion of dislocation – climb - stress and strain fields of dislocation – forces acting on a dislocation – stress and strain fields of dislocation – forces acting on a dislocation – energy of dislocation – interaction – between dislocation densities – dislocation and crystal growth – Dislocation – Frank – Read mechanism - point defects - twinning.

Reference Books

1. Crystallography and crystal defects, A. Kelley, G.W. Groves & P. Kidd, Wiley
2. Crystallography applied to Solid State Physics, A.R. Verma, O.N. Srivastava, NAI
3. Solid State Physics, A.J.Dekker, Macmillan, (1967).
4. Lasers Theory and Applications, K.Thyagarajan, A.K. Ghatak, Plenum Press
5. Lasers and Non-Linear Optics, B B Laud, New Age International.
6. Solid State Physics, S.L. Gupta and V.Kumar, Pragati Prakashan.
7. Introduction to Theory of Solids, H.M. Rosenberg, Prentice Hall.
8. Solid State Physics,J.S. Blakemore, W.B.Saunders & Co. Philadelphia.
9. Solid State Physics, N.W. Ashcroft & N.D. Mermin, Brooks/ Cole (1976).
10. Crystal Defects and Crystal Interfaces, W. Bollmann, Springer Verlag.
11. A short course in Solid State Physics, Vol. I, F.C Auluck, Thomson Press (INDIA) Ltd.
12. Crystalline Solids, Duncan McKie, Christine McKie, Wiley

PHY3CGT CRYSTAL GROWTH TECHNIQUES

Unit I

Crystal Growth phenomena (18 Hrs)

The historical development of crystal growth – significance of single crystals
- crystal growth techniques - the chemical physics of crystal growth. Theories of nucleation - Gibb's Thompson equation for vapour, melt and solution- energy of formation of spherical nucleus- heterogeneous nucleation
- kinetics of crystal growth, singular and rough faces, KSV theory, BCF theory - periodic bond chain theory- The Muller- Krumbhaar model.

Unit II

Crystal Growth from Melt and Solution Growth (18Hrs)

Growth from the melt - the Bridgmann technique – crystal pulling - Czochralski method- experimental set up - controlling parameters advantages and disadvantages.- convection in melts – liquid solid interface shape - crystal growth by zone melting -

Verneuil flame fusion technique.

Low temperature solution growth - methods of crystallization - slow cooling, solvent evaporation, temperature gradient methods - crystal growth system - growth of KDP, ADP and KTP crystals - high temperature solution growth, gel growth.

Unit III

Vapour Growth and Epitaxial Growth (18 Hrs)

Physical vapour deposition - chemical vapour transport – definition, fundamentals, criteria for transport, Specifications, STP, LTVTP & OTP - advantages and limitations of the technique, hydrothermal growth, design aspect of autoclave – growth of quartz, sapphire and garnet. Advantages of epitaxial growth, epitaxial techniques - liquid phase epitaxy, vapour phase epitaxy, molecular beam epitaxy, chemical beam epitaxy and atomic layer epitaxy

Unit IV

Materials for Semiconductor Devices (18Hrs)

Semiconductor optoelectronic properties - band structure - absorption and recombination, semiconductor alloys - group III-V materials selection - binary compounds, ternary alloys, lattice mismatch - lattice mismatched ternary alloy structures - compositional grading, heteroepitaxial ternary alloy structure - Quaternary alloys.

Semiconductor Devices - Laser diodes, light emitting diodes (LED), photocathodes, microwave Field-Effect Transistors (FET).

Reference Books:

1. The Growth of Single Crystal, R.A. Laudise, Prentice Hall, NJ.
2. Crystal Growth: Principles and Progress , A.W. Vere, Plenum Press, NY.
3. Crystal Growth Processes and methods, P.S. Raghavan and P. Ramasamy, KRU Publications.
4. A Short course in Solid State Physics, Vol. I, F.C. Auluck, Thomson Press India Ltd.
5. Crystal Growth, B.R. Pamplin, Pergamon, (1980)

6. Crystal Growth in Gel, Heinz K Henish, Dover Publication

PHY4NC NANOSTRUCTURES AND CHARACTERIZATION

Unit I

Low Dimensional Structures (18hrs)

Preparation of quantum nanostructures - size and dimensionality effects - size effects - potential wells - partial confinement - conduction electrons and dimensionality - Fermi gas and density of states - properties dependent on density of states - excitons - single-electron tunneling - applications - infrared detectors - quantum dot lasers - superconductivity.

Microelectromechanical Systems (MEMS) - Nanoelectromechanical Systems (NEMS) –Fabrication of nanodevices and nanomachines - Molecular and Supramolecular Switches.

Unit II

Carbon Nanostructures (18hrs)

Carbon Molecules - Nature of the Carbon Bond - New Carbon Structures - Carbon Clusters -Small Carbon Clusters - Carbon Nano tubes - Fabrication - Structure – Electrical Properties - Vibrational Properties - Mechanical Properties - Applications of Carbon Nano Tubes - Computers - Fuel Cells - Chemical Sensors - Catalysis – Mechanical Reinforcement - Field Emission and Shielding. Solid Disordered Nanostructures - Methods of Synthesis - Failure Mechanisms of Conventional Grain sized Materials - Mechanical Properties – Nano structured Multi layers -Electrical Properties - Porous Silicon - Metal Nano cluster - Composite Glasses.

Unit III

Thermal, Microscopic and Infrared Analysis (18 Hrs)

Thermal analysis – DTA, DSC and TGA – methodology of DTA, DSC and TGA and Instrumentation.

Microscopy – Electron microscopy – Principles and instrumentation – resolution limit

– scanning tunnelling microscopy – principles – scanning tunnelling microscope - SEM & TEM. Atomic force microscope – Instrumentation.

IR spectrophotometers – Theory and Instrumentation- Applications. Fourier transform techniques – FTIR principles and instrumentation. Raman spectroscopy – Principles, Instrumentation and Applications. Microwave Spectroscopy -Instrumentation and Applications

Unit IV

Mass Spectrometry, Resonance Spectroscopy (18 Hrs)

Mass Spectrometry - Principle – Instrumentation – Types of ions produced in a Mass spectrometer - Interpretation of Mass spectra – Applications.

NMR – Principles and Instrumentation – Chemical shift - Spin-spin coupling - Applications of NMR - Electron spin resonance spectrometry – Theory of ESR – Instrumentation - Interpretation of ESR spectra - Applications.

Reference Books:

1. Introduction to Nanotechnology, Charles P. Poole, Jr. and Frank J. Owens, Wiley, (2003)
2. MEMS/NEMS: micro electro mechanical systems/nano electro mechanical systems Volume 1, Design Methods, Cornelius T. Leondes, Springer, (2006).
3. Instrumental methods of Chemical Analysis, G. Chatwal & Sham Anand, Himalaya
4. Introduction to Infrared and Raman spectroscopy, Norman D Colthup, Lawrence H Daly and Stephen E Wiberley, Academic press, NY.
5. Instrumental methods of analysis, H.H. Willard, L.L. Merrit, J.A. Dean & F.A. Settle, CBS Pub.
6. Principles of Instrumental analysis, Skoog and West – Hall – Sanders Int.
7. Instrumental methods of chemical analysis, G W Ewing, MGH
8. Scanning Tunnelling Microscopy, R. Wiesendanger & H.J. Guntherodt, Springer
9. Thermal Analysis, Wesley W.M. Wendlandt , Wiley.

PHY4MS(P) MATERIAL SCIENCE PRACTICALS

1. Ultrasonic Interferometer – ultrasonic velocity in liquids
2. Ultrasonic Interferometer – Young's modulus and elastic constant of solids
3. Determination of dielectric constant
4. Determination of forbidden energy gap
5. Determination of Stephan's constant
6. Determination of Fermi energy of copper
7. Study of ionic conductivity in KCl / NaCl crystals
8. Thermoemf of bulk samples of metals (aluminium or copper)
9. Study of physical properties of crystals (specific heat,thermal expansion,thermal conductivity,dielectric constant)
10. Study of variation of dielectric constant of a ferro electric material with temperature(barium titanate)
11. Study of variation of magnetic properties with composition of a ferrite specimen
12. Four probe method – energy gap
13. Energy gap of Ge or Si
14. Hall effect – Hall constant
15. Thin film coating by polimerisation
16. Measurement of thickness of a thin film
17. Study of dielectric properties of a thin film
18. Study of electrical properties of a thin film(sheet resistance)
19. Growth of single crystal from solution and the determination of its structural,electrical and optical properties (NaCl,KBr,KCl,NH_4Cl etc.)
20. Determination of lattice constant of a cubic crystal with accuracy and indexing the Bragg reflections in a powder X-ray photograph of a crystal
21. Observation of dislocation – etch pit method

22. Michelson Interferometer – Thickness of transparent film
23. X-ray diffraction – lattice constant
24. Optical absorption coefficient of thin films by filterphotometry
25. Temperature measurement with sensor interfaced to a PC or a microprocessor
26. ESR spectrometer – g factor
27. Beam profile of diode laser
28. Track width of a CD using laser beam
29. He – Ne laser- verification of Malus law , measurement of Brewster angle, refractive index of a material

3.3.4 BUNCH - D: THEORETICAL PHYSICS

PHY3AP ASTROPHYSICS

Unit I

Basic Concepts in Astrophysics (18 Hrs)

A brief history of the universe; big-bang hypothesis; the synthesis of helium; Gravitational contraction, free fall, hydrostatic equilibrium; equilibrium of a gas of non-relativistic particles; equilibrium of a gas of ultra-relativistic particles, equilibrium and the adiabatic index; star formation, conditions for gravitational collapse, contraction of a protostar, conditions for stardom; The Hertzsprung – Russell diagram, luminosity and surface temperature

Unit II

Properties of Matter and Radiation (18 Hrs)

Electrons in stars – degenerate electron gas, density-temperature diagram, electrons in massive stars; Photons in stars – The Photon gas, radiation pressure in stars, The Saha equation, ionization in stars, stellar interiors, stellar atmosphere.

Unit III

Thermonuclear Fusion and Heat Transfer in Stars (18 hours)

The physics of nuclear fusion, barrier penetration, fusion cross-section, thermonuclear reaction rates. Hydrogen burning- proton-proton chain, Carbon Nitrogen cycle, solar neutrinos. Helium burning, carbon production Heat transfer by conduction by ions and electrons, radiation, convection.

Unit IV

Stellar Structure and stellar evolution (18 hours)

Simple stellar models; pressure, density and temperature inside stars; modeling the Sun, solar luminosity; minimum and maximum mass of stars. White dwarfs- mass, central density and radius, collapse of a stellar core, the onset of collapse, nuclear photodisintegration, electron capture, the aftermath. Neutron stars- the size of neutron stars, gravitational binding energy of neutron stars, rotating neutron stars and pulsars, The maximum mass of neutron star; black holes.

Text Book:

1. The Physics of Stars, A.C Phillips, 2nd Edn. John Wiley & Sons Ltd. (Chapters I to VI)

Reference Books:

1. Stellar Interiors, Hansen and Kawler, Springer Verlag.
2. Astrophysics – Stars and Galaxies, K.D.Abyankar, Universities Presss.
3. Stars: their structure and evolution, R.J. Taylor, CambridgeUniversity Press.
4. Introduction to Modern Astrophysics, B.W. Carroll & D.A.Ostie, Addison Wesley.
5. A Course on Theoretical Astro physics, Vol. II, T. Padmanabhan, Cambridge Uni. Press.
6. AnIntroduction to Astrophysics, Baidyanath Basu, Prentice Hall India.

PHY3ND NONLINEAR DYNAMICS

Unit I

Basic Concepts (18 Hrs)

What is Nonlinearity? Dynamical Systems: Linear and Nonlinear Systems-Linear Superposition Principle - Working Definition of Nonlinearity.

Linear and Nonlinear Oscillators - Linear Oscillators and Predictability - Damped and Driven Nonlinear Oscillators - Forced Oscillations – Primary Resonance and Jump Phenomenon (Hysteresis) Secondary Resonances (subharmonic and superharmonic) Nonlinear Oscillations and Bifurcations

Unit II

Qualitative Features of non-linear systems (18 Hrs)

Autonomous and Nonautonomous Systems - Dynamical Systems as Coupled First-Order

Differential Equations; Equilibrium Points ; Phase Space/Phase Plane and Phase Trajectories:

Stability, Attractors and Repellers ; Classification of Equilibrium Points: Two-Dimensional Case - General Criteria for Stability; Limit Cycle Motion

– Periodic Attractor- Poincar´e–Bendixson Theorem. Higher Dimensional Systems - Lorenz Equations ; More Complicated Attractors - Torus - Quasiperiodic Attractor - Poincar´e Map - Chaotic Attractor ; Dissipative and Conservative Systems - Hamiltonian Systems

Unit III

Chaos in Dissipative Systems (18 Hrs)

Bifurcations and Onset of Chaos in Dissipative Systems: Some Simple Bifurcations- Saddle- Node Bifurcation -The Pitchfork Bifurcation - Transcritical Bifurcation - Hopf Bifurcation ; Discrete Dynamical Systems ; The Logistic Map - Equilibrium Points and Their Stability - Periodic Solutions or Cycles -Period Doubling Phenomenon - Onset of Chaos – Lyapunov Exponent - Bifurcation Diagram - exact Solution at $a = 4$ - Logistic Map: A Geometric Construction of the Dynamics – Cobweb

Chaos in Dissipative Nonlinear Oscillators and Criteria for Chaos: Bifurcation Scenario in Duffing Oscillator - Period Doubling Route to Chaos - Intermittency Transition - Quasiperiodic Route to Chaos - Strange Nonchaotic Attractors (SNAs) ; Lorenz Equations - Period Doubling Bifurcations and Chaos ; Necessary Conditions for Occurrence of Chaos - Continuous Time Dynamical Systems -Discrete Time Systems

Unit III

Chaos in Conservative Systems (18 Hrs)

Poincar´e Cross Section; Possible Orbits in Conservative Systems - Regular Trajectories - Irregular Trajectories - Canonical Perturbation Theory: Overlapping Resonances and Chaos; H´enon–Heiles System - Equilibrium Points - Poincar´e Surface of Section of the System - Numerical Results; Periodically Driven Undamped Duffing Oscillator ; The Standard Map - Linear Stability and Invariant Curves - Numerical Analysis: Regular and Chaotic Motions; Kolmogorov–Arnold–Moser Theorem (qualitative ideas only).

Text Book

1. Nonlinear dynamics: integrability, chaos, and patterns, M. Lakshmanan & S. Rajasekar, Springer Verlag, (Chapters 1-5,7)

Reference Books:

1. Deterministic Chaos, N. Kumar, Universities Press.
2. Chaos and Nonlinear Dynamics, RC. Hilborn, Oxford University Press.
3. Chaotic Dynamics: An Introduction, G.L. Baker, and J.P. Gollub, CUP, 1993.
4. Deterministic Chaos, H.G. Schuster, Wiley, N.Y., 1995.
5. Chaos in Dynamical System, E. Ott, Cambridge University Press.
6. Encounters with Chaos, D. Gullick, MGH, 1992.
7. Introduction to Chaos and coherence, J. Froyland, IOP Publishing Ltd.
8. Nonlinear Dynamics and Chaos, J.M.T. Thomson& I. Stewart, John Wiley & Sons.

PHY4QFT QUANTUM FIELD THEORY

Unit I

Path Integrals and Quantum Mechanics (18 Hrs)

Review of single particle relativistic wave equations – Klein- Gordon equation, Dirac equation, Maxwell and Proca equations; Path integral formulation of quantum mechanics; perturbation theory and the S matrix; Coulomb scattering; Functional calculus: differentiation, generating functional for scalar fields. Functional integration

Unit II

Path Integral Quantization of Scalar and Spinor Fields (18 Hrs)

Free particle Green's functions, Generating functional for interacting field; φ^4 theory – generating functional, 2-point function, 4-point function; generating functional for connected diagrams; fermions and functional methods, The S – matrix and reduction formula, pion-nucleon scattering amplitude, scattering cross-section

Unit III

Path Integral Quantization of Gauge Field Fields (18 Hrs)

Propagators and gauge conditions in QED; Non-abelian gauge fields and Faddeev - Popov method; Self-energy operator and vertex functions; Ward – Takahashi identities in QED, Becchi – Rouet – Stora transformations; Slavnov – Taylor identities.

Unit IV

The Weinberg – Salam Model (18 hours)

Field theory vacuum; the Goldstone theorem; Spontaneous symmetry breaking of gauge symmetries; superconductivity; Higgs boson; The Weinberg – Salam model; Experimental confirmation of the models

Text Book

1. Quantum Field Theory, Lewis H. Ryder, 2nd Edn, Cambridge University Press, (1996), (Chapters 5, 6, 7, 8.),

PHY4SC(P) SPECIAL COMPTATIONAL PRACTICALS

(The experiments are to be done on the PC by developing the required algorithm and program including graphical displays. Students may use C++ or Python.)

1. Trajectory of motion of (a) projectile without air resistance (b) projectile with air resistance
2. Phase space trajectories of a pendulum- with and without damping.
3. Phase space trajectories of a pendulum – with non-linear term.

4. Trajectory of a particle moving in a Coulomb field (Rutherford scattering) and to determine the deflection angle as a function of the impact parameter
5. Trajectory of a ion in the combined Coulomb and nuclear potential and determine the angle of scattering for different impact parameters
6. Simulation of the wave function for a particle in a box - To plot the wave function and probability density; Schrödinger equation to be solved and eigen value calculated numerically.

7. Iterates of the logistic map.
8. Bifurcation diagram for the logistic map.
9. Calculation and plotting of the Lyapunov exponents.
10. Plotting of Julia set.
11. Plotting of Mandelbrot set.
12. Creating a fractal by Iteration Function Scheme

Reference Books:

1. Computational Physics- RC Verma, P.K. Ahluwalia & K.C. Sharma-New Age.
2. Chaos & Fractals- Peitgen, Jurgens & Saupe – Springer.

3.4 OPTIONAL ELECTIVE BUNCH

PHY4OE: OPTOELECTRONICS

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 - self-focusing - 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, (Chapter 16)

Reference Books:

1. Semiconductor optoelectronic devices: Pallab Bhattacharya, Pearson(2008)
2. Optoelectronics: An introduction to materials and devices, Jasprit Singh, Mc Graw Hill International Edn., (1996).
3. Optical waves in crystals: Propagation and Control of Laser Radiation, A. Yariv and P. Yeh, John Wiley and Sons Pub. (2003)

Blue Print

PHY3OE Optoelectronics

Module	Hours *(Total 72 hours)*	1 weight *(6 questions out of 10)*	2 weight *(4 questions out of 6)*	4 weight *(4 questions out of 8)*	Total weight *(30 weight out of54)*
I	**20**	**3**	**2**	**2**	**15**
II	**16**	**2**	**1**	**2**	**12**
III	**18**	**2**	**2**	**2**	**14**
IV	**18**	**3**	**1**	**2**	**13**

Questions from all the modules of the syllabus shall be included in Parts A, B and C of the question paper. Not more than 2 questions can be included in Part A from each module whereas in part B, a minimum of two questions has to be there from each module. In Part C, one question from each module is to be included.

M.Sc DEGREE (C.S.S.) EXAMINATION
THIRD SEMESTER - PHYSICS
PHY3OE - OPTOELECTRONICS

Time: 3 Hours **Maximum Weightage: 30**

PART A

Answer any ***six*** *questions, each carries weight 1*

1. Explain briefly double heterojunction LED
2. State and explain Ramos theorem.
3. Explain the working of magneto optic modulator.
4. What is a saturable absorber?
5. Compare Lorentzian and Gaussian line shape functions.
6. What is additive pulse mode locking?
7. Explain different types of signals.
8. Explain the growth of a beam during the Q-switching process.
9. Find the Z transform and ROC of the following sequence $3^n U(n)$.
10. Draw the flow chart for radix 2 FFT.

(6 x 1 = 6)

PART B

(Answer any **four** questions, each carries weight 2)

11. Derive the expression for the optical output power in LED.
12. Explain the structure and working of edge emitted LED.
13. Discuss different types of noises in photodectoctors.
14. A rectangular glass block of thickness 100 μm and length 20 mm is used as a Kerr cell. The input light is polarized parallel to the applied field along the z direction. What is the applied voltage to induce a phase change of π?
15. Explain the process of sum and difference frequency generation. Explain why a liquid medium cannot act like a second order nonlinear medium.
16. A He-Ne laser operating at 632 nm has an output power of 1 mW with a 1 mm beam diameter. The reflectivity of the output mirror is 99%. Calculate the ratio A/b.

what is the effective black body temperature of the laser. The laser line width is 0.15 x 10^9 Hz.

(4 x 2 = 8)

PART C

Answer ALL questions.(Each question carries a weight of 4)

17. (a) Explain the principle and working of liquid crystal display.

Or

(b) Explain the principle and working of LED.

18. (a)Describe the processes of a) optical bistability b) Phase matching in birefringent crystals c) optical parametric oscillation.

Or

(b) Discuss diode laser principle, characteristics and structure.

19. (a)Describe the amplification of light in a gain medium and derive the equation for gain coefficient.

Or

(b) Explain the principle and working of avalanche photodiode. What are the advantages over avalanche photodiode over photodiode.

20. (a) What is meant by filtering in DSP? Discuss different types of linear FIR filters.

Or

(b) Discuss two photon absorption.

(4 x 4 = 16)

PHY4SEW SOFTWARE ENGINEERING AND WEB DESIGN

Unit I

Software Engineering (18 Hrs)

Introduction to Software Engineering – Software development and Life cycle – Project Size and its categories – Planning a Software Project – Project Control – Project team standards-Design of solution strategies-Software cost estimation and evaluation techniques-Software design-design concepts and notations-Modern design techniques- Verification and validation methods-Documentation and implementation procedures-Performance of software systems.

Unit II

The HTML (18 Hrs)

What is HTML?- Basic Tags of HTML – HTML – TITLE - BODY

Starting an HTML document – The <!DOCTYPE>declaration - setting boundaries with <HTML> - the HEAD element - the BODY element - the STYLE element and the SCRIPT element.

Formatting of text – Headers-Formatting Tags - PRE tag - FONT tag - Special Characters. Working with Images - META tag - Links – Anchor Tag.

Lists – Unordered Lists-Ordered Lists-Definition Lists

Tables – TABLE, TR and TD Tags-Cell Spacing and Cell Padding- Colspan and Rowspan

Frames – Frameset-FRAME Tag-NOFRAMES Tag

Unit III

The HTML (18 Hrs)

Forms – FORM and INPUT Tag - Text Box - Radio Button-Checkbox - SELECT Tag and Pull Down Lists - Hidden-Submit and Reset.

Some Special Tags – COLGROUP-THREAD, TBODY – TFOOT – blank - self, parent – top –IRFRAME – LABEL - Attribute for <SELECT> - TEXTAREA

Style sheets

Introduction to scripting and HTML – purpose of scripting – JavaScript – VB Script – including scripts in an HTML document

Unit IV JAVASCRIPT

(18Hrs)

JavaScript Variables and Data Types – Declaring Variables-Data

Types Statements and Operators

Control Structures – Conditional Statements-Loop Statements

Object Based Programming – Functions-Executing Deferred Scripts-Objects

Message Box in JavaScript – Dialog Boxes-Alert Boxes-Confirm Boxes-Prompt Boxes

JavaScript with HTML – Events-Event Handlers

Forms – Forms Array – form validation

Ideas about Dreamweaver or Microsoft

Publisher Text Books

1. Software Engineering, R.S. Pressman, McGraw Hill
2. Software Engineering Concepts, R.E. Fairley, McGraw Hill
3. HTML4, 2nd Edn. Rick Darnell, Techmedia
4. HTML, The Complete Reference, Tata Mc Graw Hill
5. JavaScript Programmers Reference, Cliff Wootton, Wrox Press Inc.
6. Beginning JavaScrpit, Paul Wilton, Wrox Press Inc. 1st Edn.

Reference Books

1. Software Engineering – A Practitioner's Approach, R.S. Pressman, MGH
2. Software Engineering, Ian Sommerville, 6th Edn. Pearson (2001)
3. Mastering HTML4 – Ray D.S. and Ray E.J. – BPB
4. The JavaScript Bible, Danny Goodman, John Wiley & Sons Inc.

PHY4TFN THIN FILM AND NANO SCIENCE

Unit I

Thin Film (18 Hrs)

Nucleation – Langmuir theory of condensation – Theories of nucleation – Liquid like coalescence and growth process – Epitaxial growth – Structural defects in thin films – Electrical conduction in metallic, semiconducting and insulator films. Optical properties of thin films.

Unit II

Deposition of Films (18 Hrs)

Production of Vacuum, Different types of vacuum pumps, Measurement of Vacuum Gauges, Working principle, Deposition of thin films, Various deposition techniques, Thickness measurement – optical methods, thickness monitors - Thin film applications.

Unit III

Nano materials and Applications (18 hours)

Nano structured Crystals -Natural Nano crystals -Crystals of Metal-Nano particles –Nano particle Lattices in Colloidal Suspensions -Photonic Crystals.

Synthesis and purification of carbon nanotubes, Single-walled carbon nanotubes and multiwalled carbon nanotubes, Structure-property relationships, physical properties, applications.

Overview of different nano materials available, Potential uses of nano materials in electronics, robotics, computers, sensors in textiles, sports equipment, mobile electronic devices, vehicles and transportation. Medical applications of nano materials.

Unit IV

Synthesis of Nano materials (18hrs)

Top-down techniques: photolithography, other optical lithography (EUV, X-Ray, LIL), particle-beam lithographies (e-beam, focused ion beam, shadow mask evaporation), probe lithographies, Bottom-up techniques: self-assembly, self-assembled mono layers, directed assembly, layer-by-layer assembly. Combination of Top-Down and Bottom-up techniques: current state-of-the-art.

Pattern replication techniques: soft lithography, nano imprint lithography. Pattern transfer and enhancement techniques: dry etching, wet etching, pattern growth techniques (polymerization, directed assembly).

Reference Books:

1. Thin film phenomena, K.L Chopra, McGraw Hill, New York
2. Thin film fundamentals, A. Goswami, New Age International
3. Vacuumm deposition of Thin films, L. Holland, Chapman Hall, London
4. Handbook of thin film Technology, L.I Maissel and R. Glang, McGraw Hill
5. Optical Properties of Thin Films, O. S. Heaven, Dover Publications
6. Nano: the essentials, T. Pradeep, TMH, 2007
7. Nanoscale Materials, L.M. Liz-Marzán & P.V. Kamat, Kluwer Academic Pub. (2003)
8. Nanoscience, Nanotechnologies and Nanophysics, C. Dupas, P. Houdy & M. Lahmani, Springer-Verlag , (2007).
9. Nanotechnology 101, John Mongillo, Greenwood Press, (2007).
10. What is What in the Nanoworld A Handbook on Nanoscience and Nanotechnology, Victor E. Borisenko and Stefano Ossicini , WILEY-VCH Verlag, (2008).
11. Introduction to Nanotechnology, Charles P. Poole, Jr. and Frank J. Owens, Wiley
12. Semiconductor Nanostructures for Optoelectronic Applications, Todd Steiner, ARTECH HOUSE, (2004).
13. Nanotechnology and Nano-Interface Controlled Electronic

Devices, M. Iwamoto, K. Kaneto, S. Mashiko Elsevier Science, Elsevier Science, (2003).

14. Semiconductors for Micro and Nanotechnology—An Introduction for Engineers Jan G. Korvink and Andreas Greiner, WILEY-VCH Verlag, (2002).

PHY4GRC GENERAL RELATIVITY AND COSMOLOGY

Unit I

Basic Concepts in relativity and tensor analysis (18 Hrs)

Overview of special relativity - Principles of special relativity - Line interval, Proper time, Lorentz transformation, Minkowski spacetime, Lightcones, Relativistic momentum 4-vectors, Lorentz transformation of electromagnetic field

Conceptual foundations of GR and curved spacetime - Principle of equivalence, Connection between gravity and geometry, Form of metric in Newtonian limit, Metric tensor and its properties, Concept of curved spaces and spacetimes, Tangent space and four vectors, Tensor algebra, Tensor calculus, Covariant differentiation, Parallel transport, Riemann curvature tensor Geodesics, Particle trajectories in gravitational field

Unit II

Einstein's field equations (18 Hrs)

Einstein's field equations, Definition of the stress tensor, Bianchi identities and conservation of the stress tensor, Einstein's equations for weak gravitational fields, The Newtonian limit, Derivation of Schwarzschild metric, Basic properties of Schwarzschild metric coordinate- systems and nature of R=2M surface, Effective potential for particle orbits in Schwarzschild metric, general properties, Precession of perihelion, Deflection of ultra relativistic particles, Gravitational red-shift.

Unit III

Applications of General Relativity (18 Hrs)

Gravitational waves - Wave equation in linearised theory, Plane waves, Transverse traceless gauge, Effect on test particles, Principles of detection and generation of gravitational waves Types of detectors, Landau-Lifshitz formula, Hulse Taylor binary pulsar Models of the universe - Friedmann-Robertson-Walker models, Hubble's law, Angular size, Source counts, Cosmological constant, Horizons

Unit IV

Big Bang model (18 Hrs)

Relics of the big bang - The early universe, Thermodynamics of the early universe, Primordial neutrinos, Helium synthesis and other nuclei, Microwave background

Formation of large scale structure - Jeans mass in the expanding universe, Growth in the postrecombination era, Observational constraints, Elementary ideas on structure formation

Observations of the cosmological significance - Measurement of Hubble's constant, Anisotropy of large-scale velocity fields, Age of the universe, Abundance of light nuclei, Dark matter, Microwave background, Gravitational wave stochastic background.

Text Books:

1. First course in general relativity, B. F. Schutz Cambridge: Cambridge University Press.
2. General Relativity and Cosmology, J. V. Narlikar Delhi: Macmillan Company of India Ltd.
3. General Relativity, I. R. Kenyon, Oxford University Press.
4. Classical Theory of Fields, Vol. 2, L. D. Landau and E. M. Lifshitz, Oxford : Pergamon Press.

5. Introduction to Cosmology, 3rd Edition, J. V. Narlikar, Cambridge University Press.