Master of Science

PHYSICS

PROGRAM STRUCTURE AND SYLLABUS

2019-20 ADMISSION ONWARDS

(UNDER MAHATMA GANDHI UNIVERSITY PGCSS REGULATIONS 2019)

BOARD OF STUDIES IN PHYSICS (PG)

MAHATMA GANDHI UNIVERSITY

2019

GENERAL SCHEME OF THE SYLLABI

Theory Courses: There are fifteen theory courses in all four semesters in the M.Sc. Program. 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 will have three core courses and Semester IV will have one core course. One elective course is in semester III and two elective courses are insemester IV. An Elective Bunch has three theory courses.

Practicals: All four semesters will have a course on laboratory practicals. The laboratory practicals of Semesters I, II and IV are common courses. The Semester III laboratory practical course will subject to the Elective Bunch. 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.

Project: The project of the PG program should be 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/co11ege/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.

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.

Course Structure of M.Sc. Physics Program:

This is the PG program followed by all affiliated colleges under Mahatma Gandhi University. The detailed structure of the Core courses common to all students of the program is given in Table 2.

The Elective Bunche:

The elective consists of a bunch of three theory courses and one laboratory course. The first theory course and the laboratory course of a bunch are placed in the Semester III, while the second and third are in Semester IV. The course structure of the Electives Bunche is given in Table 1.

Table:1 The Elective Bunch

Materials Science Specialization

Semester	**CourseCode**	**Course Title**	No. of Hrs / week	**Credits**
3	PH810301	Solid State Physics for Materials	**3**	**3**
4	PH810402	Science of Advanced Materials	**5**	**3**
4	PH810403	Nanostructures and Materials Characterisation	**5**	**3**
3	PH810302	Advanced Practicals in MaterialsScience	**10**	**5**

Table: 2 Structure of MSc Physics under PG-CSS 2019

Semester	Course Code	Name of the courses	No of hrs / week	Credits
I	PH010101	Mathematical methods in Physics – I	3	3
	PH010102	Classical Mechanics	4	4
	PH010103	Electrodynamics	4	4
	PH010104	Electronics	4	4
	PH010105	General Physics Practicals	10	4
		Total for Semester 1	**25**	**19**
II	PH010201	Mathematical methods in Physics – II	4	4
	PH010202	Quantum Mechanics – I	3	4
	PH010203	Statistical Mechanics	4	4
	PH010204	Condensed Matter Physics	4	4
	PH010205	Electronics Practicals	10	4
		Total for Semester 2	**25**	**20**
III	PH010301	Quantum Mechanics – II	4	4
	PH010302	Computational Physics	4	4
	PH010303	Atomic and Molecular Physics	4	4
		Elective – 1	3	3
		Advanced Elective Practicals	10	5
		Total for Semester 3	**25**	**20**
IV	PH010401	Nuclear and Particle Physics	5	4
		Elective – 2	5	3
		Elective – 3	5	3
	PH010402	Computational Physics Practicals	10	4
	PH010403	Project	-	5
	PH010404	Comprehensive viva voce	-	2
		Total for Semester 4	**25**	**21**
		Grand Total		**80**

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.

Evaluation(Both internal and external)to be done by the teacher is based on a six point scale as shown in the table below

Grade	**Grade Points**
A+	**5**
A	**4**
B	**3**
C	**2**
D	**1**
E	**0**

Direct Grading System based on a 7 – point scale is used to evaluate the performance of students in both External and Internal Examinations .

For all courses (theory & practical) / semester/overall program letter grades and **GPA/SGPA/CGPA** are given in the following table

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

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 2.2and Table2.3. . The components of the internal evaluation for project and comprehensive viva- voce and their weights are as in the Table 2.4and Table2.5The 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.

There shall be no separate minimum grade point for internal evaluation of Theory, Practical, Project, and Comprehensive viva-voce. No separate minimum is required for Internal evaluation for a pass, but a minimum **C** grade is required for a pass in an external evaluation. However, a minimum **C grade** is required for pass in a course.

Attendance ,Assignment and seminar

Attendance is not a component for the internal evaluation.But 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.

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 2.4

The internal evaluation of comprehensive viva-voce is to done as per the following general criteria given in Table 2.5

Table 2.2 Theory-Internal

For Theory(Internal)- Components and Weightage

	Components	**Weightage**
i.	Assignment	1
ii	Seminar	2
iv	Best Two Test papers	1 each (2)
	Total	**5**

Table 2.3 Practical-Internal

For Practical(Internal)- Components and Weightage

	Components	**Weightage**
	Written/Lab test	2
	Lab involvement and Record	1
	Viva	2
	Total	**5**

Table 2.4 Project- Internal

For Project(Internal)- Components and Weightage

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

Table 2.5 Comprehensive Viva- Internal

Comprehensive viva (Internal)- Components and Weightage

Components	Weightage
Subject of special interest, fundamental physics, topics covering all semesters and awareness of current and advanced topics.	5
Total	**5**

General Instructions

i. The assignments/ seminars / test papers are to be conducted at regular intervals.. 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 areto be kept in the college for future references. The consolidated grades ineach course should be uploaded to the University Portal at the end of eachsemester 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 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.

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.

Question Paper Pattern for Theory Courses.

All the theory question papers are of three hour duration. All question papers will have three parts. The question shall be prepared in such a way that the answers can be awarded **A+,A,B,C,D,E.**

Part A: Questions from this part are very short answer type. Eight 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 eight. A minimum of two questions must be asked from each unit of the course.

Part B: Part B consists of problem solving and short essay type questions from the course concerned. Six questions out of eight given have to be answered. Each question has a weight two making the Part B to have total weight twelve. Minimum of three problems should be asked in Part B ..

Part C: Part C will have four questions. One question from each unit must be asked . Each question will have a weight five making the total weight ten in Part C.
Maximum weight for external evaluation is **30.**Therefore Maximum Weighted Grade Point (WGP) is **150**

Different types of questions shall be given different weights to quantify their range as shown below:

	Type of Questions	**Weight**	**Number of questions to be answered**
Part A	Short Answer type questions	1	8 out of 10
Part B	Short essay/ problem solving type questions	2	6 out of 8
Part C.	Long Essay type questions	5	2 out of 4

Practical, Project and Viva Voce Examinations

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 even' 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.

Table 2.5 Project- External

For Project(External) Components and Weightage

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

Comprehensive 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.

Table2.6 Comprehensive viva-voce(External)-components and weightage

Components	**Weightage**
Subject of special interest, fundamental physics, topics covering all semesters and awareness of current and advanced topics.	15
Total	**15**

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

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.

2. Evaluation Second stage– Calculation of Grade Point Average **(GPA)** of a course (to be done by the University)

3. Evaluation Third stage -Semester Grade Point Average **(SGPA)** (to be done by the University)

4. Evaluation- Fourth stage - Cumulative Grade Point Average**(CGPA)** (to be done by the University)

M.Sc. PHYSICS SYLLABUS

INTRODUCTION

This chapter deals with the syllabi of all core courses, Elective courses of the MSc. Physics program. The semester wise distribution of the courses is given.

In the semester III and semester IV, the courses from elective bunch will come as opted by the colleges concerned.

CORE COURSES

SEMESTER I

PH010101: MATHEMATICAL METHODS IN PHYSICS – I

Total Credits: 3

Total Hours: 54

Objective of the course: The objective of this course is to make students have an idea of vector, matrices and tensors, it's physical interpretation and applications.

UNIT I

Vector analysis (8 hrs)

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

Curvilinear co-ordinates(8 hrs)

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

UNIT II

Linear vector space(8 hrs)

1.1 Definition of linear vector space 2.2 Inner product of vectors 2.3basis sets 2.4Gram schmidt ortho normalization 2.5Expansion of an arbitrary vector2.6Schwarz inequality

Probability theory and distribution(6 hrs)

2.7 Elementary Probability Theory 2.8 Binomial Distribution2.9 Poisson Distribution 2.10 Gaussian Distribution 2.11Central Limit Theorem

UNIT III

Matrices(12hrs)

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

UNIT IV

Tensors(12 hrs)

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

Recommended Text Books:

1. Mathematical methods for Physicists, G.B. Arfken& H.J. Weber 5th edition, Academic Press.
2. Mathematical Physics , V.Balakrishnan, Ane Books Pvt Limited
3. Introduction to Mathematical Physics – Charles Harper, PHI
4. Vector Analysis & Tensor Analysis – Schaum's Outline Series, M.R.Speigel, Mc Graw hill
5. Mathematical methods for physics and engineering, K F Riley, M P Hobson, S J Bence, Cambridge university press.

Recommended References:

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

PH010102: CLASSICAL MECHANICS

Total Credits: 4

Total Hours: 72

Objective of the course:

After completing the course, the students will (i) understand the fundamental concepts of the Lagrangian and the Hamiltonian methods and will be able to apply them to various problems; (ii) understand the physics of small oscillations and the concepts of canonical transformations and Poisson brackets ; (iii) understand the basic ideas of central forces and rigid body dynamics; (iv) understand the Hamilton-Jacobi method and the concept of action-angle variables. This course aims to give a brief introduction to the Lagrangian formulation of relativistic mechanics.

UNIT 1

Lagrangian formulation (14 hrs)

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

Hamiltonian formulation: (4hrs)

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

UNIT II

Small oscillations (8hrs)

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

Canonical transformations and poisson brackets (10 hrs)

2.4 Equations of canonical transformations; Four basic types of generating functions and the corresponding basic canonical transformations. Examples of canonical transformations - identity transformation and point transformation. 2.5 Solution of harmonic oscillator using canonical transformations.

2. 6 Poisson Brackets ; Fundamental Poisson Brackets; Properties of Poisson Brackets 2.7 Equations of motion in Poisson Bracket form; Poisson Bracket and integrals of motion; Poisson's theorem; Canonical invariance of the Poisson bracket.

UNIT III

Central force problem (9hours)

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

Scattering in a central force field - Scattering in a Coulomb field and Rutherford scattering cross section.

Rigid body dynamics (9hrs)

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

UNIT IV

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

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

Classical mechanics of relativity (6 hrs.)

4.5 Lorentz transformation in matrix form; velocity addition; Thomas precession. 4.6 Lagrangian formulation of relativistic mechanics; Application of relativistic Lagrangian to (i)motion under a constant force (ii) harmonic oscillator and (iii) charged particle under constant magnetic field.

Recommended Text Books

1. Classical Mechanics: Herbert Goldstein , Charles Poole and John Safko, (3/e); Pearson Education.
2. Classical Mechanics: G. Aruldhas, Prentice Hall 2009.

Recommended References:

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

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

PH010103: ELECTRODYNAMICS

Total credits: 4

Total hours: 72

Objective of the course**:** Electromagnetic force is one of the four forces that exist in nature with a prominent role in the daily activities of human being. So it is necessary to know the physics of this force from the basics of two inter twinned phenomena called electricity and magnetism. Hence the course aims to impart proper understanding of electricity magnetism and electrodynamics; wave nature of electromagnetic field and its properties; electromagnetic field radiating out of accelerated charges and the impact of relativity in electromagnetism along with confined propagation of electromagnetic wave.

UNIT 1

Electrostatics, Magnetostatics and basics of Electrodynamics(18 hrs)

1.1 Electrostatics: Electric field of a polarized object- Electric field in a - conductor-dielectric - electric displacement -Gauss's law in dielectric medium-linear dielectric medium-. Boundary condition across dielectric (ε_{r1})-dielectric (ε_{r2}), conductor-dielectric (ε_r), conductor-free space (ε_r=1) interface. 1.2 Uniqueness theorem and electrostatic potential-Solving Poisson's and Laplace equations for boundary value problems 1.3 Method of images- point charge -line charge above a grounded conducting plane. 1.4 Potential at large distance-multipole expansion due to a localized charge distribution-Electric field of a dipole. 1.5 Magnetostatics: Biot-Savart law- divergence and curl of B- Ampere's law. Magnetic vector potential-multipole expansion of vector potential-boundary conditions - Magnetic field inside matter-Magnetization (M)-Magnetic flux density (B)-Auxiliary field (H). 1.6 Electrodynamics: Electromotive force - motional emf - Faraday's law-, electrodynamic equations - displacement current. 1.7 Uniform sinusoidal time varying fields E and B and Maxwell's equations in free space and matter. Boundary conditions of electric and magnetic field 1.8 Conservation laws- continuity equation-Poynting's theorem-Maxwell's stress tensor- momentum conservation.

UNIT II

Electromagnetic waves (18 hrs)

1.1Wave equation for E and B- monochromatic plane waves- energy- momentum 1.2 Propagation of em waves through linear media- Reflection and transmission of a plane wave at normal - oblique incidence.1.3 Electromagnetic waves in a conducting medium. Reflection at conducting surface- frequency dependence of permittivity 1.4 Dispersion of electromagnetic waves in non-conductors, conductors and plasma medium

UNIT III

Electromagnetic radiation (18 hrs)

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

UNIT IV

Relativistic electrodynamics and Waveguides (18 Hrs)

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

Recommended textbooks:

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

Recommended References:

1. Electromagnetic waves and radiating systems Edward C Jordan, Keith G Balamin, Printice Hall India Pvt.Ltd
2. Elements of Electromagnetic, Mathew N. O Sadiku, Oxford University Press
3. Antenna and wave propagation, K.D Prasad, Satyaprakashan, New Delhi
4. Electromagnetism problems with solutions, Ashutosh Pramanik, PHI.

PH010104: ELECTRONICS

Total credits: 4

Total hours: 72

Objective of the course: Electronics is the study of the flow of charge (electron) through various materials and devices such as semiconductors, resistors, inductors, capacitors, nanostructures etc. All applications of electronics involve the transmission of power and possibly information.

UNIT I

Op-amp with Negative Feedback (16 Hrs)

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

UNIT II

The Practical Op-amp (6 Hrs)

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

General Linear Applications (with design) (14Hrs)

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

UNIT III

Frequency Response of an Op-amp (6 Hrs)

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

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

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

UNIT IV

Comparators and Converters (8 Hrs)

4.1. Basic comparator- Zero crossing detector.4.2. Schmitt Trigger – Comparator characteristics- Limitations of op-amp as comparators. 4.3. Voltage to frequency and frequency to voltage converters.4.4. D/A and A/D converters- Peak detector – Sample and Hold circuit.

IC555 Timer (3 Hrs)

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

Analog Communication (7 Hrs)

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

Recommended Text Books:

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

Recommended References:

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

PH010105:GENERAL PHYSICS PRACTICALS

Total credits: 4

Total hours: 180

** Minimum number of experiments to be done 12*

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

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

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

References

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

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

R3. Kit Developed for doing experiments in Physics- Instruction manual, R.Srenivasan ,K.R Priolkar, Indian Academy of Sciences.
R4. Advanced Practical Physics, S.P singh, PragatiPrakasan,
R5. Practical Physics, Gupta, Kumar, PragatiPrakasan.
R6. An advanced course in Practical Physics, D.Chattopadhayay, C.R Rakshit, New Central Book Agency Pvt. Ltd: ****for error analysis only.**

SEMESTER II

PH010201:MATHEMATICAL METHODS IN PHYSICS – II

Total Credits: 4

Total Hours: 72

Objective of the course: Introduce the concepts of Laplace and Fourier transforms. Introduce the Fourier series and it's application to solutions of partial differential equations.

UNIT 1

Complex analysis (18 hrs)

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

UNIT II

Integral transforms (18 hrs)

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

UNIT III

Special functions and differential equations (18 hrs)

3.1 Gamma Function 3.2 Beta Function 3.3 Symmetry Property of Functions 3.4 Evaluation of Beta functions3.5 Other forms of Beta Functions --Transformation of P Functions 3.6 Evaluation of Gamma Functions 3.7 Other forms of Gamma Functions-Transformation of Gamma Functions 3.8 Relation between Beta and Gamma Functions 3.9 Evaluation of Integrals 3.10 Bessel's Differential Equation, 3.11 Legendre Differential Equation 3.12 Associated Legendre Differential Equations 3.13 Hermite Differential Equations 3.14 Laguerre Differential Equations (Generating function, recurrence relation, orthogonality condition, Rodrigues formulae for all functions)

UNIT IV

Partial differential equations (18 hrs)

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

Recommended Text Books:-

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

Recommended Reference Books:

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

PH010202 QUANTUM MECHANICS-I

Total Credits: 4

Total Hours: 54

Objective of the course:

This course aims to develop the basic structure of quantum Mechanics. After completing the course, the student will (i) understand the fundamental concepts of the Dirac formalism (ii) understand how quantum systems evolve in time; (iii) understand the basics of the quantum theory of angular momentum. Also, this course enable the student to solve the hydrogen atom problem which is a prelude to more complicated problems in quantum mechanics.

UNIT I

Basics Formulation of Quantum Mechanics (20 hours)

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

UNIT II

Quantum Dynamics (16 hours)

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

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

UNIT III

Theory of Angular Momentum (14 hours)

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

UNIT IV

The Hydrogen Atom (4 hours)

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

Recommended Text Books:

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

Recommended References:

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

2. Quantum Mechanics: 500 Problems with Solutions: G Aruldhas, Prentice Hall of India.
3. Quantum Mechanics Demystified: David McMohan, McGrawHill 2006.
4. Introductory Quantum Mechanics: Richard L Liboff, Pearson Education .
5. Introduction to Quantum Mechanics: D.J. Grifith, Pearson Education.
6. Quantum Mechanics : V. K. Thankappan, New Age International.
7. Quantum Mechanics: An Introduction: Walter Greiner and Allan Bromley, Springer.
8. Quantum Mechanics : Non-Relativistic Theory(Course of Theoretical Physics Vol3): L. D. Landau and E. M. Lifshitz, Pregamon Press.
9. The Feynman Lectures on Physics Vol3, Narosa.
10. www.nptel/videos.in/2012/11/quantum-physics.html
11. https://nptel.ac.in/courses/115106066/

PH010203 STATISTICAL MECHANICS

Total Credits: 4

Total Hours: 72

UNIT I (22 hrs)

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

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

UNIT II(18 hrs)

2.1. Grand canonical Ensemble2.1.1. Equilibrium between system and energy-particle reservoir.2.1.2.A system in grand canonical ensemble.2.1.3.Physical significance of various statistical quantities.2.1.4. Examples.2.1.5. Fluctuations in grand canonical ensemble.2.2. Formulation of Quantum Statistics2.2.1.Quantum mechanical ensemble

theory.2.2.2.Density matrix.2.2.3.Statistics of various ensembles.2.2.4.Examples (an electron in magnetic feilds, free particle in a box).
2.2.5. A system composed of indistinguishable particles.

UNIT III(22hrs)

3.1. Quantum Theory of Simple Gases3.1.1. Ideal gas in quantum-micro canonical ensemble.3.1.2.Ideal gas in other quantum mechanical ensembles.3.1.3.Statistics of the occupation numbers3.2.Ideal Bose Systems3.2.1.Thermodynamic behaviour of ideal Bose gas.3.2.2.Thermodynamics of black body radiation. The field of sound waves .3.3. Ideal Fermi Systems3.3.1.Thermodynamics of ideal Fermi gas.3.3.2.Magnetic behaviour of ideal fermi gas.3.3.3.Electron gas in metals.4.

UNIT IV(10 hrs)

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

Recommended Text books:

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

Recommended Reference Books:

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

PH010204: CONDENSED MATTER PHYSICS

Total Credits: 4

Total Hours: 72

UNIT 1

Wave Diffraction and the Reciprocal Lattice (5Hrs)

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

Crystal Symmetry (7Hrs)

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

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

Free Electron Fermi Gas (12 Hrs)

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

UNIT II

Energy Bands (8 Hrs)

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

Semiconductor Crystals (10 Hrs)

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

UNIT III

Phonons

Crystal Vibrations and Thermal Properties (16 Hrs)

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

UNIT IV

Magnetic Properties of Solids (14 hrs)

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

Recommended Textbooks:

1. Introduction to Solid State Physics, Charles Kittel, Wiely, Indian reprint (2015).
2. Solid State Physics, A.J. Dekker, Macmillan & Co Ltd. (1967)
3. Introduction to Solids, L V Azaroff, McGRAW-HILL BOOK COMPANY, INC.New York (1960)

Recommended References:

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

PH010205:ELECTRONICS PRACTICAL

Total credit: 4

Total hours: 180

* *Minimum number of experiments to be done 12*

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

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

1. Op-Amp parameters (i) Open loop gain (ii) input offset voltage (iii) input bias current (iv)) CMRR (v) slew rate (vi) Band width
2. Design and construct an integrator using Op-Amp (*μA741)*, draw the input output curve and study the frequency response.
3. Design and construct a differentiator using Op-Amp (*μA741) for sin wave and square wave input* and study the output wave for different frequencies.

4. Design and construct a logarithmic amplifier using Op-Amp (*μA741) and study the output wave form*.
5. Design and construct a square wave generator using Op-Amp (*μA741) for a frequency f_0.*
6. Design and construct a triangular wave generator using (*μA741) for a frequency f_0.*
7. Design and construct a saw tooth wave generator using Op-Amp (*μA741)* generator.
8. Design and construct an Op-Amp Wien bridge oscillator with amplitude stabilization and study the output wave form.
9. Design and construct a Schmidt trigger using Op-Amp μA741*, plot of the hysteresis curve.*
10. Design and construct an astable multivibrator using *μA741 with duty cycle other than 50%*
11. Design and construct a RC phase shift oscillator using *μA741for a frequency f_0.*
12. Design and construct a first and second order low pass Butterworth filter using *μA741 and plot the frequency response curve.*
13. Design and construct a first and second order high pass Butterworth filter using *μA741 and study the frequency response.*
14. Design and construct a first order narrow band pass Butterworth filter using *μA741.*
15. Solving differential equation using *μA741*
16. Design and construct ccurrent to voltage and voltage to current converter (*μA741*)
17. Astable multivibrator using 555 timer, study the positive and negative pulse width and free running frequency.
18. Monostable multivibrator using 555 timers and study the input output waveform.
19. Voltage controlled Oscillator using 555 timer
20. Design and construct a Schmitt Trigger circuit using IC 555.
21. Design and test a two stage RC coupled common emitter transistor amplifier and find th bandwidth, mid-frequency gain, input and output impedance.
22. Design and test a RC phase shift oscillator using transistor for a given operating frequency.
23. Voltage controlled Oscillator using transistor

24. Study the function of (i) analog to digital converter using IC 0800 (ii) digital to analog converter DAC 0808
25. Study the application of op-Amp (*μA741) as a d*ifferential amplifier.
26. Solving simultaneous equation using op-Amp (*μA741).*

References:

R1. Op-Amp and linear integrated circuit
Ramakanth A Gaykwad, Eastern Economy Edition, ISBN-81-203-0807-7
R2. Electronic Laboratory Primer a design approach
S. Poornachandra, B.Sasikala, Wheeler Publishing, New Delhi
R3. Electronic lab manual Vol I, K ANavas, Rajath Publishing
R4. Electronic lab manual Vol II, K ANavas, PHI eastern Economy Edition
R5. Electronic lab manual Vol II, Kuriachan T.D, Syam Mohan, Ayodhya Publishing
R6. An advanced course in Practical Physics, D.Chattopadhayay, C.R Rakshit, New Central
Book Agency Pvt. Ltd: ****For error analysis only.**

SEMESTER III

PH010301: QUANTUM MECHANICS-II

Total Credits: 4
Total Hours: 72
Objective of the course:

This course aims to extend the concepts developed in the course ‘ Quantum Mechanics-I . After completing this course, the student will (i) understand the different stationary state approximation methods and be able to apply them to various quantum systems; (ii) understand the basics of time-dependent perturbation theory and its application to semi-classical theory of atom-radiation interaction; (iii) understand the theory of identical particles and its application to helium; (iv) understand the idea of Born approximation and the method of partial waves. Also, this course will introduce the student to the basic concepts of relativistic quantum mechanics.

UNIT I

Approximation Methods for Stationary States(18 hrs)

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

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

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

UNIT II

Time-Dependent Perturbation Theory (18 hrs)

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

UNIT III

Identical Particles andScattering Theory (18hrs)

3.1 Bosons and fermions; anti-symmetric wave functions and Pauli's exclusion principle. 3.2 The Helium Atom.3.3 The Asymptotic wave function - differential scattering cross section and scattering amplitude 3.4 The Born approximation-scattering amplitude in Born approximation; validity of the Born approximation; Yukawa potential ; Coulomb potential and the Rutherford formula. 3.5 Partial wave analysis- hard sphere scattering; S-wave scattering for finite potential well; Resonances and Ramsauer-Townsend effect .

UNIT IV

Relativistic Quantum Mechanics(18 hrs)

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

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

Recommended Text Books:

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

Recommended References:

1. Quantum Mechanics (Schaum's Outline Series): Yoav Peleg etal., Tata McGraw Hill .Education Private Limited, 2/e.
2. Quantum Mechanics: 500 Problems with Solutions: G Aruldhas, Prentice Hall of India.
3. Problems and Solutions in Quantum Mechanics: Kyriakos Tamvakis, Cambridge University Press.
4. Introductory Quantum Mechanics: Richard L Liboff, Pearson Education.
5. Quantum Mechanics: V. K. Thankappan, New Age International.
6. A Textbook of Quantum Mechanics: P M Mathews and R Venkatesan, Tata McGraw Hill.
7. Quantum Mechanics: Non Relativistic Theory (Course of Theoretical Physics Course Vol3) : L. D. Landau and E. M. Lifshitz, Pregamon Press.

8. Relativistic Quantum Mechanics: James D Bjorken and Sidney D Drell, Tata McGraw Hill 2013
9. www.ntpel/videos.in/2012/11/quantum-physics.html
10. https://nptel.ac.in/courses/115106066/

PH010302: COMPUTATIONAL PHYSICS

Total Credits:4

Total Hours: 72

Objective of the Course:

To help the students to have the basic idea about the techniques used in physics to solve problems with the help of computers when they cannot be solved analytically with pencil and paper since the underlying physical system is very complex. After the completion of this course students might be able to develop their own Algorithms of every method described in the syllabus.

UNIT I
CurveFittingandInterpolation (20Hrs)

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

UNIT II

Numerical Differentiation and Integration(16 Hrs)

2.1 Numerical differentiation, 2.2 cubic spline method,2.3errors in numerical differentiation, 2.4 Integration of a function with Trapezoidal Rule, 2.5 Simpson's 1/3 2.6 Integration of a function with Simpson's 3/8 Rule and error associated with each. 2.7RelevantAlgorithmsforeach.

UNIT III

Numerical Solution of Ordinary Differential Equations (20Hrs)

3.1 Euler method, 3.2 modified Euler method 3.3 Runge - Kutta 4^{th} order methods – 3.4 adaptive step size R-K method, 3.5Higher order equations. 3.6 Concepts of stability.

Numerical Solution of System of Equations

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

UNIT IV

Numerical solutions of partial differential equations (16Hrs)

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

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

Recommended Text Books:

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

Recommended Reference Books:

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

PH010303: ATOMIC AND MOLECULAR PHYSICS

Total Credits: 4

Total Hours: 72

Objective of the course**:** This course isintented to develop the basic philosophy of spectroscopy. Its aims to equip the student with the understanding of (1)atomic structure and spectra of typical one- electron and two-electron systems. (2)the theory of microwave and infra-red spectroscopies as well as the electronic spectroscopy of molecules;(3)the basics of Raman spectroscopy and the nonlinear Raman effects; (4)the spin resonance spectroscopies such as NMR and ESR. This course also introduces the student to the ideas of Mossbauer spectroscopy .

UNIT 1

Atomic Spectra (18 Hrs)

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

UNIT II

Microwave and Infra Red Spectroscopy (18 Hrs)

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

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

UNIT III

Raman Spectroscopy and Electronic Spectroscopy. (18 Hrs)

3.1Quantum theory of Raman effect**;** classical theory-molecular polarizability ;Pure rotational Raman spectra of linear molecules 3.2 Raman activity of vibrations; rule of mutual exclusion; vibrational Raman spectra ;rotational fine structure 3.3 Structure determination from Raman and IR spectroscopy. 3.4 Non- linear Raman effects - hyper Raman effect - classical treatment; stimulated Raman effect - CARS, PARS - inverse Raman effect. 3.5 Electronic spectra of diatomic molecules –Born-Oppenheimer approximation, vibrational coarse structure-progressions and sequences ; intensity of spectral lines- Franck – Condon principle 3.6 Dissociation energy and dissociation products; Rotational fine structure of electronic-vibrational transition ; Fortrat parabola; Predissociation.

UNIT IV

Spin Resonance Spectroscopy (18 Hrs)

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

Recommended Text Books:

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

Recommended References:

1. Spectroscopy (Vol. 2 & 3), B.P. Straughan& S. Walker, Science
2. paperbacks 1976
3. Raman Spectroscopy, D.A. Long, Mc Graw Hill international, 1977
4. Introduction to Molecular Spectroscopy, G.M. Barrow, Mc Graw Hill
5. Introduction to Spectroscopy, D L Pavia, G M Lampman and G S Kriz, Thomson Learning Inc.
6. Modern Spectroscopy, J M Hollas, John Wiley .
7. Elements of Spectroscopy, Gupta, Kumar & Sharma, PragathiPrakshan.
8. https:// teaching.shu.ac.uk/hwb/chemistry/tutorials/molspec/nmr1.htm
9. https://ntpel.ac.in/courses/15101003/downloads/modu21/lecture23.pdf
10. https://www.ias.ac.in/article/fulltext/reso/009/0034-0049
11. https://ntpel.ac.in/courses/122101001/downloads/modu21/lec-15.pdf
12. https://www.youtube.com/watch?v=Q2Fo5BARe Go

SEMESTER IV

PH010401 NUCLEAR AND PARTICLE PHYSICS

Total Credits: 4

Total Hours: 90

Weightage:

Objective of the course:

This course aims to provide the student to build up the fundamentals of nuclear and particle physics. After undergoing this course, the student will have a knowledge about (1) the basic properties of the nucleus and the nuclear forces. (2) Major models of the nucleus and the theory behind the nuclear decay process; (3) the physics of nuclear reactions (4)the interaction between elementary particles and the conservation laws in particle physics. This course intents to impart some idea about nuclear astrophysics and the practical applications of nuclear physics.

Unit I

Nuclear Properties and Force between Nucleons (18 Hrs)

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

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

Unit II

Nuclear Models and Nuclear Decay (18 Hrs)

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

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

Unit III Nuclear Reactions (18Hrs)

3.1Types of reactions and conservation laws, energetics of nuclear reactions, isospin. 3.2 Reaction cross sections, Coulomb scattering- Rutherford formula, nuclear scattering. 3.3 Scattering and reaction cross sections in terms of partial wave amplitudes. 3.4 Compound-nucleus reactions; Direct reactions. 3.5 Resonance Reactions.

Unit IV

Particle Physics (18 Hrs)

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

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

5.1 Particle and nuclear interactions in the early universe, primordial nucleosynthesis 5.2 Stellar nucleosynthesis (for both $A<60$ and $A>60$) 5.3 Higg's boson and the LHC experiments; detection of gravitational waves and LIGO (qualitative ideas only)

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

Recommended Text Books:

1. Introductory Nuclear Physics, K. S. Krane JohnWiley
2. Nuclear Physics, S.N. Ghoshal, S. Chand & Company.
3. Nuclear Physics: Problem-based Approach Including MATLAB, Hari M Agarwal, PHI Learning Private Limited, Delhi .

Recommended References:

1. Problems and Solutions in Atomic, Nuclear and Particle Physics: Yung-Kuo Lim, World Scientific.
2. Nuclear Physics, S.N. Ghoshal, S. Chand & Company.
3. Introduction to Nuclear and Particle Physics : V M Mittal , R C Verma, S C Gupta (Prentice Hall India .

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

PH010402 COMPUTATIONAL PHYSICS PRACTICALS

Note

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

Introduction to computational facility in the Centre

Introduction to the IDE used in the center and commands for execution of a program. Inputting data and variables, outputting results on a console. Achieving arithmetic operations and use of data and variables in the software used at the Centre .Usage of decisions and loops. Creating an array and using array operations. Method of declaring functions and function calling. Writing data to a file and reading data from a file. Getting a graph from a data available using plotting software available with the Centre.

1. Find the root of the given non-linear equations by the bisection method

2. Find the root of the given non-linear equations by the Newton-Raphson method

3. A thermistor gives following set of values. Calculate the temperature corresponding to the given resistance using Lagrange interpolation.

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

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

4. Newton's forward interpolation / backward interpolation.

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

<u>Steam Table</u>

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

Temperature: 1750 C (This is only a sample data. Students should be capable to handle another set of data from any other physical phenomena)

6. Value of some trigonometric function [say f(θ) = tan (θ)] for θ=15,30,45,60,75 are given to you. Using appropriate interpolation technique calculate value of f(θ) for a given value.
7. Numerical integration by the trapezoidal rule.
8. Using the trapezoidal rule, calculate the inner surface area of a parabolic reflecting mirror. (length of semi major axis , semi minor axis and height are to be given)
9. Numerical integration by the Simpson rule (both 1/3 and 3/8 rule).
10. Fit a straight line using method of least square to a set of given data without using any built in function of curve fitting. Compare your result with any built in curve fitting technique.
11. Find out the normal equations and hence fit a parabola using method of least square to a set of given data without using any built in function of curve fitting. Compare your result with any built in curve fitting technique.

12. Fit a exponential curve to the given set of data using method of least square with out using any built in curve fitting technique. Compare your result with any built in curve fitting technique.
13. Study the given function as a sum of infinite series. Compare your value with the available standard value.
14. Numerical solution of ordinary first-order differential equations using the Euler methods or the fourth order Runge-Kutta method.
15. Using technique of Monte Carlo method obtain the value of π correct to two decimal places .
16. Using Monte Carlo technique calculate the value of the given integral. Compare your result with result obtained by analytical method.
17. Write a program to solve the given system of linear equations by the Gauss elimination method.
18. Find out inverse of a given matrix by using Gauss-Jordan method.
19. Numerical solution of second-order differential equations using the fourth order Runge-Kutta method.
20. Fast Fourier Transform of a given signal.
21. Solution of Heat equation / Diffusion equation using Finite Difference Method.
22. A Duffing oscillator is given by $\ddot{x} + \delta \dot{x} + \beta x + \alpha^3 = \gamma \cos \omega t$ where δ is damping constant>0. Write a program to study periodic and aperiodic behavior
23. Study of path of a Projectile in motion with and with out air drag and compare the values .
24. A study of Variation of magnetic field B(T) with critical temperature in superconductivity
25. Generation of output waveform of a Half wave / full wave rectifier.
26. Charging /discharging of a capacitor through an inductor and resistor
27. Variation in phase relation between applied voltage and current of a series L.C.R circuit
28. Phase plot of a pendulum (driven and damped pendulum)
29. Study variation of intensity along a screen due to the interference from Young's double slit experiment. Also study the variation of intensity with variation of distance of the screen from the slit.

30. Study variation of intensity along a screen due to the diffraction due to a grating .Also study the variation of intensity with variation of distance of the screen from the grating.
31. A particle obeying F-D statistics is constrained to be in 0 to 2eV at 300K. Calculate Fermi energy of this particle assuming kT =.025eV at 300K
32. Solve the following differential equation and study periodic and aperiodic behavior.

$$\frac{dy}{dx} = \sigma(y - x), \qquad \frac{dy}{dx} = x(\rho - z) - y, \qquad \frac{dy}{dx} = xy - \beta z$$

33. Study the difference equation $X_{n+1} = mX_n (1 - X_n)$ and obtain periodic and aperiodic behavior.
34. Generate a standing wave pattern and study change in pattern by changing its various parameters.

Reference books

1. Computational Physics: An Introduction, R.C. Verma, P.K. Ahluwalia & K.C. Sharma, New Age India, Pvt. Ltd ,2014.
2. An Introduction To Computational Physics, 2nd Edn,Tao Pang Cambridge University Press, 2010
3. Numerical Recipes: The Art of Scientific Computing 3rd Edn, William H. Press Cambridge University Press, 2007.

BUNCH- MATERIAL SCIENCE

PH810301: SOLID STATE PHYSICS FOR MATERIALS

Total Credits: 3

Total Hours: 54

UNIT 1

Crystal defects [18h]

1.1 Crystal Imperfection- point imperfections- vacancy, Frenkel and Schottky imperfections,

1.2 dislocations- Edge, screw, Burger's vector critical resolved shear stress,

1.3 dislocation motion , dislocation reaction, dislocation energy, slip;

1.4 surface and volume imperfections – stacking faults; Fracture, twinning [Ref. 5]

1.5 Voids in close packing- size, coordination and significance,

1.6 Pauling's rule and applications; Allotropy, polymorphism [Ref. 4]; polytypism

UNIT II

(A) Atomic Diffusion [6h]

2.1 Fick's laws, solution and applications;

2.2 Kirkendall effect, Atomic model of diffusion and other diffusion processes and mechanisms

(B) Crystal binding: [12h]

2.3 Crystals of inert gas, Van der Waals- London interaction, Repulsive interaction, equilibrium lattice constants, cohesive energy, 2.4 Ionic crystals- Madelung energy, Madelung constant,

2.5 Covalent crystals, metals, hydrogen bond; Born-Haber cycle

UNIT III

(A) Phase diagrams: [6h]

3.1 Phase diagram rules, unary and binary phase diagrams,

3.2 microstructural changes during cooling, applications

(B) Excitations in solids [12h]

3.3 Plasma optics, plasmons;

3.4 Polaritons, LST relation;

3.5 electron-phonon interaction: polarons;

3.6 Kramers Kronig Relations; excitons- Frenkel and Wannier excitons, electron hole drops;

3.7 Magnons- spin wave quantization and thermal excitation of magnons.

Recommended textbooks:

1. Materials Science and Engineering- V Raghavan-PHI
2. Introduction to solid state physics- C Kittel- Wiley India
3. Solid State Physics- Wahab- Narosa

Recommended References:

1. Lectures on Solid State Physics- Georg Busch & Horst Schade; Pergamon Press
2. Callister's Materials Science and Engineering- Wiley India
3. Elementary Solid State Physics: M Ali Omar- Pearson
4. Solid State Physics- S O Pillai- New Age;
5. Introduction to solids- Azaroff-TMH;
6. Solid State Physics- Adrianus J Dekker- Macmillan

PH810402: SCIENCE OF ADVANCED MATERIALS

Total Credits: 3

Total Hours: 90

UNIT 1:
Ceramics, polymers and composites [25h]

(A) Ceramics:

1.1 Types, properties and applications of ceramics: Glass, clay, refractories, abrasives, cements, advanced ceramics, piezoelectric ceramics,

1.2 mechanical and glass properties, heat treatment of glasses, Perovskite structure, Classification of ferroelectric materials, dielectric breakdown [Ref 3].

(B) Polymers:

1.3 polymer structure and configurations, thermosetting and thermoplastic , copolymers, conducting polymers, mechanical behaviour of polymers,

1.4 Mechanisms of deformation and strengthening, crystallization, melting and glass transition; polymer types-plastics, elastomers, fibers, polymerisation and applications.

(C) Composite materials:

1.5 particle reinforced composites, fiber –reinforced composites, structural composites, Semimetals

UNIT II
(A) Optical properties of materials [10h]

2.1 Absorption processes, photoconductivity, photovoltaic effect, colour centers-types and generation

2.2 Luminescence – photoluminescence, cathodoluminescence, electroluminescence, injection luminescence, radiative recombinationGaussian Beam- Amplitude, properties, quality; [Ref 1]Optical coherence- temporal, spatial [Ref 2]

(B) Lasers [10h]:

1.3 Absorption of radiation, threshold conditions, lineshape function, population inversion and pumping threshold conditions, laser modes,

1.4 semiconductor lasers, hetero junction lasers. Methods of pulsing lasers – Q switching and mode locking

UNIT III

Photonic materials and Applied Photonics [20h]

3.1 **LEDs [5h]:** Principles, structure, materials and characteristics, heterojunction LED, SLED and ELED

3.2 **Solar cells [5 h]**- principles, characteristics, PERL, heterojunction, cascaded, and schottky barrier cells, material and design considerations [Ref 5]

3.3 Basic concepts and features of Photonic crystals, [Ref 6] Liquid crystals, [Ref 7] optics of metamaterials, [Ref 1] Amorphous semiconductors. [Ref 7] detector arrays-CCDs

3.4 Electro-optic effect, magneto-optic effect, acousto-optic effect.

UNIT IV

Superconductors, Thin films and crystal growth [25 h]

(A) Superconductors: [12 h]

4.1 Thermodynamics and electrodynamics,

4.2 BCS theory, flux quantization, type I &II superconductors,

4.3 single particle tunnelling, Josephson tunnelling, high temperature superconductors

(B) **Thin films: [7h]**

4.4 Nature- deposition technology-Resistance heating, Cathodic sputtering, interferometric film thickness measurement, Applications: Antireflection coating, solar cells and sensors.

(C) **Crystal growth:[6h]**

4.5 Mechanism of crystal growth, nucleation, classification of crystal growth methods, growth from melt-Czochralski, Bridgeman, Floatzone techniques, growth from solution - gel growth. [Ref 8, 11]

Recommended Text Books:

1. Solid State Physics- Wahab- Narosa;
2. Optoelectronics- Wilson & Hawkes- Pearson 2018;
3. Optoelectronics- Wilson & Hawkes- Pearson 2018;
4. Optoelectronics and Photonics: Principles and Practices- S O Kasap- Pearson
5. Introduction to solid state physics- C Kittel- Wiley India
6. Thin film fundamentals: A Goswami- New Age ;
7. Semiconductor Physics and devices, S.S. Islam, Oxford University press.

Recommended References:

1. Fundamentals of Photonics- Saleh and Teich- wiley India;
2. Lasers and Nonlinear Optics: B B Laud; New Age,
3. Solid State Physics- S O Pillai- New Age;
4. Solid State Physics- Wahab- Narosa;
5. Semiconductor Optoelectronic Devices: Pallab Bhattacharya- Pearson
6. Introduction to nanotechnology: Charles P Poole, Frank J Owens-wiley india
7. Elementary Solid State Physics: M Ali Omar- Pearson
8. Crystal growth: processes and methods- P.S. Raghavan and P. Ramasamy, KRU publications
9. Materials Science and Engineering- V Raghavan-PHI.
10. Essentials of Crystallography- M A Wahab- Narosa
11. Semiconductor Devices: Physics and Technology- S M Sze- Wiley India
12. Fiber optics and Optolelectronics- R P Khare- Oxford

PH810403: NANOSTRUCTURES AND MATERIALS CHARACTERISATION

Total Credits: 3

Total Hours: 90

UNIT 1

Nanostructures: Synthesis and properties [25 h]

1.1Applications of Schrodinger equation in nanoworld: particle confined in one dimension, quantum leak, penetration of barrier, 1.2 nanostructures for electronics- quantum dots, nanowires, superlattices and heterostructures1.3 Preparation of quantum nanostructures, size and dimensionality effects, single electron tunnelling. Metal nanoclusters, semiconducting nanoparticles, rare gas and molecular clusters. Self assembly and catalysis 1.4 Synthesis routes: bottom up approaches- PVD, CVD, MBE, PLD, wet chemical; 1.5 top down synthesis routes- mechanical alloying, nanolithography.

UNIT II

Nanomaterials and applications [20 h]

2.1Carbon nanostructures: carbon clusters, fullerenes, CNTs- fabrication, properties and applications , 2-D nanostructure- graphene [Ref 6]2.2 Nanostructured materials:

superparamagnetic nanoparticles, GMR, ferrofluids, colossal magnetoresistance, nanostructured thermal devices, superhydrophobic nanostructured surfaces, biomimetics; 2.3 nanomachines and nanodevices- MEMs,NEMs, nanosensors, 2.4 molecular and supramolecular switches, nanocatalysts, properties and applications of nano ZnO and TiO_2, dendrimers, micelles

UNIT III

Optical Absorption and Emission spectroscopy [20 h]

3.1Instruments for absorption photometry – radiation sources, wavelength selection, cells and sampling devices, detectors; Fundamental laws of photometry (Beer Lambert's law), spectrophotometric accuracy, precision, absorptivity, bathochromic and hypsochromic shift, Jablonski diagram 3.2 Principles of Fourier transform optical measurements- advantages of Fourier transform spectrometry, time domain spectrometry, fourier transform of interferograms. 3.3 optical atomic spectra- atomic line widths, effect of temperature;3.4 Principles and applications of Differential, difference and derivative spectroscopy, photoacoustic and thermal lens spectroscopy; General applications of uv absorption spectroscopy 3.5 Theory of fluorescence and phosphorescence spectrophotometry, PL power, total luminescence spectroscopy, fluorescence lifetime measurements, quenching and applications, principle and applications of chemiluminescence, Qualitative ideas of resonance raman spectroscopy, surface enhanced raman spectroscopy,

UNIT IV

Chemical, thermal and X-ray diffraction methods [25 h]

4.1X ray diffraction- production and detection of X-rays and X-ray spectra, Moseley's law, Geometry of an X-ray diffractometer, [Ref 3] 4.2 X-ray photoelectron spectroscopy, X-ray fluorescence, Particle size determination, Debye Scherrer formula, stress measurementAuger recombination, Auger Emission Spectroscopy, 4.3 Working of SEM, TEM, AFM and STM with instrumentation 4.4 **Mass spectrometry**: ionization methods, mass spectrometers and analyzers, correlation of mass spectra with molecular structure. 4.5 **Thermal methods**: thermogravimetry, DTA, DTG, DSC, microthermal analysis; Principles of pH measurement, potentiometry, voltammetry and electrogravimetry

Recommended Text Books: (Unit 1 & 2)

1. Introduction to nanotechnology: Charles P Poole, Frank J Owens-Wiley india
2. Textbook of nanoscience and nanotechnology- B S Murty, P Shankar, Baldev Raj, B B Rath, James Muday- Springer Univ. Press
3. Introduction to nanoscience and nanotechnology- KK Chattopadhyay and A N Banerjee-PHI
4. Introduction to Nanoscience- S M Lindsay, Oxford University Press.

Recommended Text Books: (Unit 3&4)

1. Instrumental methods of analysis- Williard, Merritt, Dean, Settle- CBS
2. Introduction to nanoscience and nanotechnology- KK Chattopadhyay and A N Banerjee-PHI
3. Introduction to Nanoscience- S M Lindsay, Oxford University Press.
4. Principles of Instrumental analysis- Holler, Skoog, Crouch-Cenage

Recommended references:

1. Instrumental methods of chemical analysis-Chatwal, Anand- Himalaya
2. Instrumental methods of chemical analysis- Galen W Ewing-MGH
3. X ray diffraction a practical approach :C Suryanarayana, M Grant Norton; Springer
2. Nanophotonics- Paras N Prasad: Wiley
3. Nanostructures and nanomaterials- G Cao and Y Wang- World Sci.
4. Graphene: Synthesis, Properties and Applications in Transparent electronic devices- P Kumar etal- Reviews in Advanced Sciences and Engineering, vol 2, pp1-21, 2013

PH810302: ADVANCED PRACTICALS IN MATERIAL SCIENCE

Total credit: 5

Total hours: 180

** Minimum number of experiments to be done 12*

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

1. Malu's law- verification
2. Optical activity- specific rotation measurement
3. Stefan's constant- torch bulb filament resistance measurement
4. Absorption coefficient of solution- path length and concentration dependence
5. XRD- Crystal Structure Determination Cubic/Hexagonal
6. XRD-Lattice Parameter Measurements
7. XRD- Phase Diagram Determination
8. XRD-Determination of Crystallite Size and Lattice Strain
9. Zeeman effect- shift of atomic energy levels
10. Laser- measurement of thread angle, pitch and the diameter of a micrometre screw
11. Thin film thickness- Newton's rings/ Michelson interferometer
12. Magneto-optic effect - Determination of Verdet constant
13. Michelson interferometer /Edser Butler method/ Fresnel's biprism- mica sheet thickness
14. Bandgap- semiconductor diode
15. Laser –Young's double slit - interference
16. Refractive index of liquid- Newton's ring /Laser/ Fresnel's biprism
17. Resolving power- lens- Laser
18. Rydberg constant- Hydrogen discharge tube
19. Particle size – corona plate
20. Comparison of thickness of thin sheets by air wedge
21. Band gap and type of optical transition (direct or Indirect using Tauc relation) from absorption spectra
22. Synthesis of metallic (Ag or Au) nanoparticles in aqueous medium and estimation particle size using absorption spectrum

23. Thermal analysis of materials from experimental data
24. Analysis of FTIR spectrum
25. Solar cell- efficiency& Fill factor
26. Laser diffraction- comparison of thickness of wires of different gauges
27. Thermistor –parameters [energy band gap]
28. Temperature sensor- silicon diode and thermocouple
29. Optical fiber- bending loss
30. Fermi energy of copper
31. ESR spectrometer- g factor
32. Verification of laws of geometrical optics- reflection and transmission coefficients, critical angle, refractive index of glass slab/ prism
33. Study of Bravais lattices with the help of models
34. Verification of Fresnel's equations
35. Spring constant-static and dynamic method
36. Coherence length of LED
37. Comparison of resistance variation of a carbon film resistor, metal wire, semiconductor and thermistor with temperature
38. Thermal diffusivity of brass
39. Young's modulus- strain gauge
40. Michelson interferometer- Sodium D lines separation
41. Fresnel's biprism- wavelength of monochromatic light

References:

1. A course of experiments with He-Ne laser- R S Sirohi, Wiley
2. Practical Physics- C L Arora, S Chand
3. X ray diffraction a practical approach :C Suryanarayana, M Grant Norton; Springer
4. Practical Physics: D Chattopadhyay, P C Rakshit; New Central Book Agency
5. Advanced practical physics: Chauhan, Singh; Pragati Prakashan

MODEL QUESTION PAPERS

M.Sc PHYSICS DEGREE C.S.S EXAMINATION

1 Semester

Faculty of Science

PH010101 – MATHEMATICAL METHODS IN PHYSICS – I

(2019 Admissions Onwards)

Time : 3 Hrs **Max Weight : 30**

SECTION – A

(Answer Any Eight Questions. Each Question Carries a Weight of 1)

1. State and Prove Gauss' divergence theorm
2. What is similarly transformation? How does it affect the eigen values and eigen vectors of a matrix?
3. State and prove Cayley – Hamiltorn Theorem for square matrices
4. Explain the central limit theorem.
5. Show the Kronecker delta is a mixed tensor of rank 2.
6. State the theorem relating line and surface integrals.
7. What are orthogonal curviliniear co-ordinates?
8. Show that the eigenvalues of Hermitian matrix are orthogonal to each other
9. Explain contra variant and covariant tensors
10. What are Christoffels 3 index symbols? (8 x 1 = 8)

SECTION – B

(Answer Any Six Questions. Each Question Carries a Weight of 2)

11. Solve the system of equations

    $x+y+3z=6$

    $2x+3y-4z=6$

    $3x+2y+7z=0$

12. Show that contraction reduces the rank of a tensor by 2?

13. Discuss the properties of Dirac delta function
14. Discuss Schwartz in equality
15. Define Christoffels symbols of first and second kind
16. Show that in Cartesian co-ordinate system contra variant covariant components of a vector are identical.
17. Discuss the features of linear vector space.
18. Explain Associate Tensors?

(6 x 2 = 12)

SECTION – C

(Answer Any Two Questions. Each Question Carries a Weight of 5)

19. Define general orthogoanal curvilinear co-ordinates and obtain various differential operators in terms of orthogoanal curvilinear co-ordinates
20. Outline the characteristics of Binominal, Poisson and Gaussion distributions
21. What are unitary and Hermitian matrices? State and prove their properties
22. Bringout the transformation laws of Christoffels symbols.

(2 x 5 = 10)

MODEL QUESTION PAPER
M.Sc. DEGRE (PGCSS0EXAMINATION
FIRST SEMESTER
FACULTY OF SCIENCE
Branch II: Physics(A) Pure Physics

PH010102 – CLASSICAL MECHANICS

Time: 3 hours Maximum Weight: 30

PART A

(Answer any **EIGHT** questions. Each question carries **1** weight)

1. Discuss the effect of holonomic constraints on the number of degrees of freedom of a system.
2. What is dissipation function? Give its physical significance.
3. State Noether's theorem.
4. Explain how the Hamiltonian of a system can be generated from its Lagrangian using Legendre transformation.
5. Distinguish between stable equilibrium and unstable equilibrium.
6. Write down the fundamental Poisson brackets.
7. What are the first integrals of a conservative central potential?
8. Explain centrifugal potential in the context of a central force field.
9. Define principal moments of inertia of a rigid body.
10. Explain Thomas precession.

(8 X 1 = 8)

PART B

(Answer any **SIX** questions. Each question carries **2** weight)

11. A bead is sliding on a wire in a uniformly rotating wire in a force free region. The wire is straight and the axis of rotation of the wire is perpendicular to the wire. Obtain the equation of motion of the bead.

12. Derive Hamilton's equations of motion from modified Hamilton's principle.

13. A simple pendulum has a bob of mass $m$with another mass m' at the moving support. Mass m' moves on a horizontal line in the vertical plane containing the bob of the pendulum. Find the normal frequencies and normal modes of vibrations.

14. Show that the transformation $Q = \sqrt{2q}\cos p\ , P = \sqrt{2q}\sin p$ is canonical.

15. Solve the problem of simple harmonic oscillator in one dimension by making use of a canonical transformation.

16. State and prove Poisson's theorem regarding Poisson brackets.

17. A particle falls freely from a height h at a place with latitude λ. Find the deflection due to Coriolis force.

18. Explain the physical significance of Hamilton's principal function.

(6 X 2 = 12)

PART C

(Answer any **TWO** questions. Each question carries 5 weight)

19. Derive Lgrange's equations of motion from Hamilton's principle.

20. Discuss the normal modes and normal coordinates of the free vibrations of CO_2 molecule.

21. Derive Euler's equation for rigid body motion. Apply it to work out the torque free motion of a symmetric top.

22. Describe how action-angle variable can be used to obtain the frequencies of a periodic system without finding a complete solution to the motion of the system. Apply this method to the linear harmonic oscillator problem.

(2 X 5= 10)

MODEL QUESTION PAPER
M.Sc. DEGRE (PGCSS0EXAMINATION
SECOND SEMESTER
FACULTY OF SCIENCE
Branch II: Physics(A) Pure Physics

PH010202 – QUANTUM MECHANICS-I

Time: 3 hours Maximum Weight: 30

PART A

(Answer any **EIGHT** questions. Each question carries **1** weight)

1. Discuss the concept of kets and bras.
2. Show that the outer product of a ket and bra is an operator.
3. What is meant by a Hermitian operator?
4. Define time evolution operator
5. What are energy eigenkets? Why are they called stationary states?
6. State and explain the Ehrenfest's theorem.
7. Give the fundamental commutation relations for angular momentum operators.
8. Write down the rotation operator for a spin half system.
9. Give the matrix elements of J_x and J_y in $|jm\rangle$ basis.
10. Express the L_z operator in spherical polar coordinate system.

(8 X 1 = 8)

PART B

(Answer any **SIX** questions. Each question carries **2** weight)

11. Obtain the matrices representing the three components of spin operator in S_z basis.

12. Show that (a) a change of basis can be accomplished by a unitary transformation. (b)Unitary equivalent observables have identical spectra.

13. Express infinitesimal translation operator in terms of momentum operator. Hence deduce the commutation relation between position and momentum operators.

14. Show that the wavefunctions in momentum space and position space are Fourier transforms of each other.

15. Solve the Schrodinger equation for the time evolution operator for a system with a time independent Hamiltonian.

16. The lifetime of hydrogen in the 2p state to decay to the 1s ground state is 1.6 ns. Calculate the spread in energy of this excited state . Also estimate the linewidth of the emitted spectral line in angstroms.

17. Calculate the commutation relations between all the three pairs of Pauli spin matrices.

18. Calculate the Clebsch-Gordon coefficients associated with the addition of two angular momenta j_1 =1/2 ; $j_2 = 1/2$.

(6 X 2 = 12)

PART C

(Answer any **TWO** questions. Each question carries 5 weight)

19. State and prove the generalized uncertainty principle.

20. Obtain the energy eigenvalues and energy eigenkets of a simple harmonic oscillator using operator method.

21. Using ladder operators, solve the eigenvalue problem for angular momentum operators.

22. Starting from the Schrodinger equation for a spherically symmetric potential, obtain the energy eigenvalues and the eigenfunctions of the hydrogen atom. Discuss the degeneracy of the energy levels of the hydrogen atom.

(2 X 5= 10)

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

First Semester

Faculty of Science

Course Code- **PH010103: ELECTRODYNAMICS**

(2019 admissions onwards)

Time: Threehours Max. Weight: 30

Section- A

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

1. What are the static and dynamic Maxwells equations?
2. What is meant by Maxwells stress tensor? Explain its significance.
3. Why TEM waves can not be transmitted through hollow waveguides?
4. Explain the term characteristic impedance.
5. What is skin depth? How it is related to the attenuation constant?
6. Distinguish between phase velocity and group velocity
7. What is meant by electric dipole radiation?
8. What is a four vector? Give the components of momentum four vector.
9. Explain proper time and proper velocity.
10. What is meant by radiative reaction?

(8 x 1 = 8)

Section B

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

11. Verify that the Poynting vector is invariant under the transformation **E'** =**E**CosΦ + **B**SinΦ and **B'** = -**E**SinΦ +**B**CosΦ. Give the physical significance of the transformation if Φ= **π**/2
12. Evaluate the magnitude of the current density **J** in a region where the vector potential is given by **A**= x^2**j** - 2xy**k** , where **j** and **k** are unit vectors.

13. Show that $\mathbf{E}^2$-$\mathbf{B}^2$ is Lorentz scalar.
14. Show that **E.B** is relativistically invariant.
15. The lowest frequency of an electromagnetic field is a rectangular waveguide is fixed at 3 MHz. What should be the dimension of the waveguide for its propagation?
16. Show that the power radiated from a magnetic dipole varies as the fourth power of the frequency.
17. Explain Gauss law in dielectric medium
18. For a TE in a rectangular wave guide, show that TE_{10} is the dominant modern

(6 x 2 = 12)

<u>Section C</u>

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

19. Derive the laws of conservation of energy and momentum in electrodynamics and show that the electromagnetic fields carry energy and momentum
20. Discuss the reflection and transmission of the electromagnetic waves at oblique incidence and obtain the Snell's law.
21. Discuss the propagation of TM waves in rectangular wave guide and obtain an expression for the cutoff frequency
22. Explain retarded potentials. Find the expressions for Lienard-Wiechert potentials.

(2 x 5 = 10)

M.Sc. PHYSICS Degree (C.S.S.) Examination

First Semester

Faculty of Science

PH010104 ELECTRONICS

(2019 admission onwards)

Time: 3hrs

Max.Weight:30

Section A

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

1. Why op-amp called operational amplifier?
2. Using aneat schematic diagram explain how op-amp canbe used asa voltage follower.
3. Discuss current to voltage converter.
4. What are the three methods of compensation?
5. Define slew rate?
6. What is an instrumentation amplifier? Give two applications.
7. What is the principle of phase discriminator?
8. What is a sample and hold circuit? Why is it needed?
9. What is an all pass filter? Where and why is it needed?
10. Write short note on stereo FM reception. (8 x 1 =8)

Section B

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

11. A 5mv, 1 KHz sinusoidal signal is applied to the input of an OP-AMP integrator for which R=100KΩ and c = 1μF. Find the output voltage.
12. Design a Weinbridge oscillator for a frequency of 900Hz.
13. The o/p voltages of a certain OP-AMP circuit changes by 20V in 4μS.What is its Slew rate?
14. Design a second order low pass filter at a high cut off frequency of 1 KHz.
15. Differentiate between inverting and non-inverting amplifiers.
16. With the help of diagram bring out the theory of phase-shift oscillator.
17. Discuss an integrator circuit using Op-Amp.
18. What is the Butterworth response? Explain (6 x 2 =12)

Section C

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

19. Define a filter? How are filters classified? Explain first order low pass butter worth filter. Discuss its frequency response.
20. With neat circuit diagrams explain the principle and operation of a Square wave generator and a triangular wave generator.
21. What is a comparator? Explain its working. Discuss with theory the working of IC 555 as an astable multivibrator.
22. Compare and contrast voltage to frequency and frequency to voltage converters.

(2x 5 =10)

MODEL QUESTION PAPER
M.SC DEGREE C.S.S EXAMINATION
Semester II
Faculty of Science
PH010201 – MATHEMATICAL METHODS IN PHYSICS – II
(2019 Admissions Onwards)

Time : 3 Hrs **Max Weight : 30**

SECTION – A
(Answer Any Eight Questions. Each Question Carries a Weight of 1)

1. What are analytic functions? Explain.
2. State Cauchy residue theorem.
3. Expand In (1+z) in a Taylor series about z = 0
4. What is infinite Fourier sine and cosine transforms?
5. What is meant inverse Laplace transforms?
6. Show that $P_n(1) = 1$ and $P_n(-1) = (-1)^n$
7. Study the heat equation
8. Show that $H_{2n}(0) = \frac{(-1)^n(2^n)_!}{n!}$
9. Obtain Laplace and Poisson's equations in Cartesian co-ordinates.
10. Write Helmholtz equation. Give any one application (8 x 1 = 8)

SECTION – B

(Answer Any Six Questions. Each Question Carries a Weight of 2)

11. Show that the real and imaginary parts of the function log *z* satisfy the Cauchy-Riemann equations when z is not zero.
12. Find the residues of $f(z) = \frac{ze^{iz}}{z^4+a^4}$ at its poles.
13. State and prove the convolution theorem.
14. Obtain the Laplace transform of a periodic function with period T.
15. Explain the method of separation of variables
16. Get the general proof of symmetry property of Green's function.
17. Prove that $\beta(\frac{1}{2}, \frac{1}{2}) = \pi$
18. Show that $\Gamma m \Gamma n = \Gamma(m+n)\, \beta(m,n)$ when m>0, n>0 (6 x 2 = 12)

SECTION – C

(Answer Any Two Questions. Each Question Carries a Weight of 5)

19. State and prove Taylors theorem for a complex function.
20. Discuss the properties of Fourier transform.
21. Bring out Green's function and apply it to scattering problem
22. Define Legendre polynomials and prove their orthogonality condition

(2 x 5 = 10)

QP Code: ······

M.Sc DEGREE(C.S.S.) EXAMINATION NOVEMBER 2019

Second Semester

Faculty of Science

PH010203 – STATISTICAL MECHANICS

(2019 admission onwards)

Time: Three hours Maximum Weight : 30

Section A(Answer any **eight** questions. Each carries weight of 1)

1. Explain the thermodynamic and statistical definitions of entropy.
2. How density of states is related to energy for a 2-D system?
3. Explain Gibb's paradox.
4. Obtain the partition function for a system of harmonic oscillators.
5. "The ensemble average of any physical quantity f is identical to the value one expects to obtain on making an appropriate measurement on the given system". Justify this statement.
6. Plot F-D distribution function at $T = 0$ K and $T > 0$ K.
7. What is meant by chemical potential?
8. Explain Fermi temperature and Fermi energy.
9. Discuss the phase separation in mixtures.
10. What is a maxwell construction for van der Waals isotherms?

Section B (Answer any **six** questions. Each question carries weight of 2,)

11. Making use of the fact that the entropy S(N,V,E) of a thermodynamic system is an extensive quantity, show that, $N\left(\frac{\partial S}{\partial N}\right)_{V,E} + V\left(\frac{\partial S}{\partial V}\right)_{N,E} + E\left(\frac{\partial S}{\partial E}\right)_{V,N} = S$
12. For an extreme relativisitic gas, the single-particle energy states is given by $\epsilon(n_x, n_y, n_z) = \frac{hc}{2L}\left(n_x^2 + n_y^2 + n_z^2\right)^{1/2}$, show that, $C_p/C_v = 4/3$.
13. Consider a rigid lattice of distinguishable spin 1/2 atoms in a magnetic field. The spins have two states, with energies $-\mu_0 B$ and $-\mu_0 B$ for spin up and down respectively. The system is at a temperature T. Obtain the heat capacity C_v and schematically plot it as a function of T.
14. Show that chemical potential is the Gibbs free energy per particle($\mu = G/N$).
15. Obtain the density matrix for a system of free particles.
16. Show that the entropy of a system in the grand canonical ensemble can be written as $S = -k\sum_{r,s} P_{r,s} ln P_{r,s}$, where $P_{r,s} = \frac{e^{-\alpha N_r - \beta E_s}}{\sum_{r,s} e^{-\alpha N_r - \beta E_s}}$
17. Derive Clapeyron equation by assuming the Gibbs potential or the chemical potential is same at the phase boundary.
18. Atomic weight of Lithium is $6.94u$ and density $0.53 gm/cm^3$. Calculate Fermi energy and Fermi temperature of electrons.

Part C (answer any**two** questions. Each question carries weight of 5,)

19. Derive Liouville's theorem and explain its consequences.
20. Obtain the canonical partition function for system in contact with a thermal reservoir at temperature T.
21. Discuss the density and energy fluctuations in Grand canonical ensemble.
22. Explain the thermodynamic behaviour of an ideal Bose gas.

M.Sc.PHYSICS Degree (C.S.S) Examination

Second Semester

Faculty of Science

PH010204 CONDENSED MATTER PHYSICS

(2019 admissions onwards)

Time: Three hours Max.Weight:30

Section –A

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

1. What is the difference between optical and acoustic mode?
2. Define density of states.
3. Briefly discuss thermal conductivity of metals.
4. Define phonon momentum.
5. Define the axis vectors of a reciprocal lattice interms of primitive cell lattice vectors.
6. What is a Brillouin zone? Give its construction.
7. Discuss about the different kinds of symmetry shown by crystals.
8. Discuss the phenomenon of antiferro magnetism.
9. How does adiabatic demagnetization produce cooling.
10. Obtain the expression for Lorentz number on the basis of quantum theory

(1x8=8)

Section –B

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

11. Calculate the glancing angle on the plane (110) of a cube rock salt (a=2.81A^{o}) corresponding to second order diffraction maximum for the X-rays of wavelength 0.71A^{o}.
12. Give three differences between dislocations in sc and fcc lattices. Compare both these with dislocations in the bcc lattice.

13. The thermal conductivity of aluminum at 20°C is $210 Wm^{-1}K^{-1}$. Calculate the electrical resistivity of aluminum at this temperature. The Lorentz number of Aluminum is $2.02x10^{-8}\Omega m$.

14. The Fermi energy of copper is 7eV. Calculate (a) the Fermi momentum of electron in copper (b) the de Brogile wavelength of the lectron and (c) the Fermi velocity.

15. Prove the in one diamensional diatomic lattice both acoustic and optical brances in dispersion curve mmet the zone boundary normally.

16. Draw temperature dependence of susceptibility of all types of magnetic materials. Comment on them

17. A para magnetic has 10^{28}atoms/m^3.. The magnetic moment of each atom is $1.8x10^{-23}Am^{2.}$ Calculate the paramagnetic susceptibility at 300K. What would be the dipole moment of a bar of this material 0.1m lonf and 1 sq cm cross-section placed in the field of $8x10^4$A/m.

18. If in a one diamensional lattice, x= M/m<<1, prve that the square of the widths of the optical and acoustic brances are in the ratio x:4

(6x2=12)

<u>Section –C</u>

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

19. Explain the Ewald construction. Discuss how reciprocal lattice concept is useful in

X-ray diffraction studies.

20. Discuss Debye model of lattice heat capacity. Derive an expression for it.

21. Discuss Weiss theory of ferro magnetism. Mention its merits and demerits

22. Explain the vibrations of crystal with monoatomic basis. Obtain dispersion relation and discuss first brillouin zone, long wave length limit and phase and group velocities. **(2x5=10)**

MODEL QUESTION PAPER
M.Sc. DEGRE (PGCSS0EXAMINATION
THIRD SEMESTER
FACULTY OF SCIENCE
Branch II: Physics(A) Pure Physics

PH010301 – QUANTUM MECHANICS-II

Time: 3 hours Maximum Weight: 30

PART A

(Answer any **EIGHT** questions. Each question carries **1** weight)

1. Discuss the validity of the WKB method.
2. Give the Bohr-Sommerfeld quantization rule for a potential well.
3. Using WKB, method, obtain the tunneling probability in alpha decay.
4. What is meant by the interaction picture?
5. Give the expression for energy shift in time dependent perturbation.
6. Distinguish between bosons and fermions.
7. Write down the solution of the Klein-Gordon equation for a neutral spin 0 particle.
8. Express the Klein-Gordon equation in the Schrodinger form.
9. What is meant by *zitterbewegung*?
10. Explain how the stability of vacuum is assured in Dirac's theory.

(8 X 1 = 8)

PART B

(Answer any **SIX** questions. Each question carries **2** weight)

11. A particle of charge q that undergoes a simple harmonic is subjected to a constant electric field along the x-direction. Find the first order correction in energy of the particle.

12. Using variational method, estimate the ground state energy of a particle moving under a delta function potential.

13. A particle, which is initially in the ground state of an infinite potential well with walls at x=0 and x=L. It is subjected to a potential $V(t) = V(0)\, e^{-t/\tau}$. Calculate to first order the probability of transition from the ground state to the first excited state. The energies and energy eigenfunctions of the infinite potential well are given by $E_n = \frac{n^2\pi^2\hbar^2}{2mL^2}$; $\psi_n = \sqrt{\frac{2}{L}}\sin\left(\frac{n\pi x}{L}\right)$; $n =$ 1,2,3 ...

14. Discuss electric dipole approximation.

15. Obtain the relation connecting differential cross section and scattering amplitude

16. Using the Born approximation, calculate the differential cross section for the scattering of an alpha particle of energy 8 MeV from a gold nucleus. Atomic number of helium=2; atomic number of gold=79. Scattering angle = 60^0.

17. Obtain the continuity equation for the Klein-Gordon equation.

18. Prove the anti-commutation relations among Dirac matrices (alpha matrices and beta matrix).

(6 X 2 = 12)

PART C

(Answer any **TWO** questions. Each question carries 5 weight)

19. Develop the degenerate perturbation theory for stationary states and apply it to the first order Stark effect in hydrogen.

20. Derive the expression for total transition probability in case of constant perturbation and obtain Fermi's golden rule.

21. Discuss the partial wave analysis and apply it to the problem of hard sphere scattering.

22. Obtain the non-relativistic limit of the Dirac equation and hence deduce the spin of the Dirac particle.

(2 X 5= 10)

MODEL QUESTION PAPER
M.Sc DEGREE (PGCSS)EXAMINATION
Third Semester
Faculty of Science
Branch II : Physics (A) Pure Physics
PH010302 - Computational Physics
(2019 Admission onward)

Time : Three Hours Maximum Weight 30

Part A
(Answer any Eight Questions. Each question carries 1 weight)

1) What do we understand by the term "First difference of a function y" in case of interpolation? How do we represent it symbolically ? Give one example also.
2) Define cubic spline function and explain its properties
3) A function y= *f*(x) is tabulated below. Calculate the slope of the function when x =1.4 using Newton's forward difference formula.

x	1.1	1.2	1.4	1.6	1.8	2	2.2
y	2.2783	3.3.3201	4.0552	4.9530	6.0496	7.3891	9.0250

4) Write down the equation we use to integrate a function using Simpson's 3/8 rule and explain each term used.
5) Using Euler method calculate the value of y at t=0.1 in five steps. Given $\frac{dN}{dt}=.5N$ with initial conditions N=10 at t=0.
6) Solve the the following system of equations, x+2y+3=0 ,2x+y=3 using Gauss-Jordan elimination method.
7) Find the inverse of a matrix A= $\begin{bmatrix} 2 & 3 \\ 4 & 5 \end{bmatrix}$ using Gauss-Jordan method
8) Using power method calculate Eigen value and eign matrix of A= $\begin{bmatrix} 2 & 3 & 3 \\ 3 & 3 & 2 \\ 3 & 2 & 3 \end{bmatrix}$
9) Write in short note on how do we obtain Schmidt two level explicit formula
10) Explain what is meant by Buffoon's needle problem

(8X1=8)

Part B
(Answer any Six Questions. Each question carries 2 weight)

11) Water jet from an inclined hose is observed and the height of the water jet h, and horizontal distances x from the tip of the hose are tabulated as shown below. Assuming water follows a parabolic path, fit an appropriate curve and hence calculate the velocity with which water comes out.

x in meter	.1	.15	.2	.25	.3	.35	.4
h in meter	.075	.09375	.1	.09380	.0749	.04375	0

12) By using method of least squares, find the relation of the form $y=ax^b$ to the data tabulated below:

x	2	3	4	5
y	27.8	62.1	110	161

13. The following data gives the melting point of an alloy of lead and zinc where T is the temperature in ^{0}C and P is the percentage of lead in the alloy. Find the melting point of the alloy containing 75% of lead using Newton's interpolation method.

P	60	70	80	90
T	226	250	276	304

14. A river is 100meters wide. Depth, d, at various distances,x, from one bank of the river is tabulated as shown below. With the help of Simpson's 1/3 rule ,calculate the volume of water flowing through the river in one hour when velocity of water flow is 3m/s .

X in meter	0	10	20	30	40	50	60	70	80	90	100
d in meter	0	5	8	9	10	12	9	7	5	2	0

15. Use 4th order R-K method to solve $\frac{dy^2}{dx^2}=x\frac{dy}{dx}+y^2$ Given y(0)=1 , and $\frac{dy}{dx}_{at\,x=0}=2$

Take h=0.2 and find y and y' at x=0.2

16. Find all eigen values and the corresponding eigen vectors of the matrix $\begin{bmatrix} 1 & \sqrt{2} & 2 \\ \sqrt{2} & 3 & \sqrt{2} \\ 2 & \sqrt{2} & 1 \end{bmatrix}$

by Jacobi's method

17. Solve the equation $y'=x^3+y$, with initial condition y(0)=1 to compute y(.02) using Euler's modified formula with h=0.01.
18. Write a short note on using Mote Carlo method for evaluation of integrals.

(6X2=12)

Part C

(Answer any Two Questions. Each question carries 5 weight)

19. Starting from basics deduce Newton's Divided Difference interpolation formula.

20. Obtain the generalised trapezoidal rule of the form.

$\int f(x) = \frac{h}{2} y_0 + y_n + 2(y_1 + y_2 + y_3 + ... + y_{n-1}) + E_n$ through geometrical approach . Write the expression for the error term E_n .

21. Explain why the concept of stability is important in selecting the step size while trying to solve differential equations numerically using Euler's method.

22. Use Crank-Nicholson method to find the numerical solution of the following parabolic partial differential equation after one time step; Tt=Txx; with 0<x<1 ; subjected to the initial condition T(x,0)=1 ,with 0<x<1 and boundary condition T(0,t)=T(1,t)=0 with t>=0. Compute the solution by taking Δt= 1/32.

(2X5=12)

MODEL QUESTION PAPER
M.Sc. DEGRE (PGCSS0EXAMINATION
THIRD SEMESTER
FACULTY OF SCIENCE
Branch II: Physics(A) Pure Physics

PH010303 – ATOMIC AND MOLECULAR PHYSICS

Time: 3 hours Maximum Weight: 30

PART A

(Answer any **EIGHT** questions. Each question carries **1** weight)

1. What is Paschen-Back effect?
2. Explain hyperfine structure in atomic spectral lines?
3. What is the information derivable from the rotational spectrum of a molecule?
4. Explain what is meant by Morse potential.
5. Differentiate between skeletal vibrations and group frequencies.
6. How does the polarizability of a molecule influence its Raman activity?
7. Explain stimulated Raman effect.
8. Distinguish between progressions and sequences.
9. What is meant by chemical shift in NMR spectrum?
10. Explain Fermi contact interaction.

(8 X 1 = 8)

PART B

(Answer any **SIX** questions. Each question carries **2** weight)

11. The term symbol for an atomic state is $^2P_{3/2}$. What are the values of L,S and J for this state? Calculate the Lande' g-factor for this state. What type of Zeeman effect this atom will give?

12.. Derive all possible terms arising out of the combination of an s-electron with a p-electron in LS coupling scheme. Also calculate the separation between singlet state and triplet states.

13.Explain collision broadening and Doppler broadening

14. The rotational constant of $^1H^{35}Cl$ is observed to be $10.5909 cm^{-1}$. Determine the value of B for $^1H^{37}Cl$ and $^2D^{35}Cl$.

15. When H_2 molecule is irradiated with 435.8nm line, the Raman Stoke's vibrational line appear at 18551.05 cm^{-1}. Find the wavenumber of the ant-Stoke's line, the force constant and zero point energy. Atomic weight of hydrogen= 1.008.Avagadro number is 6.023×10^{23} . Obtain the relation connecting differential cross section and scattering amplitude

16. The band origin of a transition in a molecule is observed at 19,378 cm^{-1} . The rotational fine structure indicates that the rotational constants in excited and ground states are 17527 cm^{-1} and 16326 cm^{-1} respectively. Estimate the position of the band head. Which state has larger internuclear distance?

17. Electron spin resonance is observed for atomic hydrogen with an instrument operating at 9.5 GHz. If the g value for the electron in the hydrogen atom is 2.0026, what is the magnetic field applied?

18. Calculate the recoil velocity of a free Mossbauer nucleus of mass $1.67 \times 10^{-25}\ kg.$, when emitting a gamma ray of wavelength 0.1 nm. What is the Doppler shift of the gamma ray to an outside observer?

(6 X 2 = 12)

PART C

(Answer any **TWO** questions. Each question carries 5 weight)

19. Discuss the fine structure of one electron atoms and derive an expression for the fine structure splitting in hydrogen like atoms.

20. Describe the spectrum of a diatomic vibrating rotator assuming Born-Oppenheimer approximation. Discuss the changes in the spectrum when this approximation breaks down

21. Describe how the molecular structure is determined using Raman and IR spectroscopies.

22. Explain the relaxation processes in nuclei and obtain the Bloch equations for the components of nuclear magnetization.

(2 X 5= 10)

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

Fourth Semester

Faculty of Science

Course Code- **PH010401 NUCLEAR AND PARTICLE PHYSICS**

(2019 admissions onwards)

Time: Three hours Max. Weight: 30

Section- A

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

1. Compare nuclear scattering with optical diffraction.
2. What is meant by isotopic shift? How it is useful in isotope separation.
3. Explain the term electric quadrupole moment.
4. How can you explain the continuous spectrum of β decay?
5. Differentiate between direct reaction and compound nucleus reactions.
6. What is meant by reaction cross section?
7. Why a proton cannot decay except at GUT energies?
8. Explain the role of Higg's mechanism in symmetry breaking of electro-weak interaction
9. Explain 'r process' and 's process'
10. .What are the advantages of carbon dating using accelerator mass spectroscopy technique?

(8 x 1 = 8)

Section B

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

11. Briefly explain the nuclear force as an exchange force mediated by mesons.
12. Explain the properties of deuteron
13. Explain forbidden β decay
14. A free neutron decays into a proton by the emission of β^- particles of maximum kinetic energy 0.782MeV.If the rest mass of the electron and neutron are 0.0005486u and 1.008665u respectively, find the mass of proton.(1u=931.478MeV)

15. A tritium gas target is bombarded with a beam of monoenergetic protons of kinetic energy 3 MeV to produce He^3 and neutron. What is the kinetic energy of the neutrons emitted at 30^0 to the incident beam?(H^1=1.007276u,n^1=1.008665u,H^3=3.016056u and He^3=3.016030u)
16. Detail the classification of elementary particles.
17. With the help of conservation laws ,determine which of the following reactions are allowed through strong interactions. If they are forbidden, explain why?

    a) $p + p \rightarrow K^+ + \Sigma^+$
    b) $\pi^- + p \rightarrow n + \gamma$
    c) $p \rightarrow e^+ + \gamma$
    d) $K^0 \rightarrow \pi^- + \pi^+$

18. .What is meant by positron emission tomography.How it can be used in brain scans?

(6 x 2 = 12)

Section C

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

19. Describe shell model in nuclear physics. How is it successful in explaining parity, magnetic diple moment and quadrupole moment?
20. Explain coulomb scattering and derive differential cross section for elastic coulomb scattering.
21. Explain Quark model. What are the experimental evidences supporting quark model. What is meant by colored quarks and what is its significance?
22. Describe primordial nucleosynthesis

(2 x 5 = 10)

MSc PHYSICS DEGREE EXAMINATION

III SEMESTER
Faculty of Science

PH810301 SOLID STATE PHYSICS FOR MATERIALS

(2019 admissions onwards)

Time: 3 hours Max. Weight:30

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

1. What is polytypism?
2. How do Van der Waals- London interaction evolve?
3. Distinguish between Frenkel and Wannierexcitons?
4. Explain edge dislocation.
5. Discuss the formation of stacking faults in fcc crystals.
6. What is Kirkendall effect?

7. Write a note on plasmons.
8. Explain the role of polarons in crystals.
9. What is polymorphism?
10. State Puling's rules.

(8x1=8)

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

11. Determine the fraction of atoms in a given solid with energy equal to or greater than 1.4eV at room temperature and 5 times room temperature.
12. Find the radius of the largest sphere that will fit into the void produced by the bcc packing of atoms of radius R.
13. Explain the importance of Born-Haber cycle.
14. Briefly discuss the phase diagram rules.
15. Discuss the role of phase diagram in zone refining of materials.
16. What is LST relation? Explain its importance.
17. What are the different types of diffusion mechanisms? Explain.
18. Assume that the potential energy of two particles in the field of each other is given by $U(R) = -\frac{A}{R} + \frac{B}{R^9}$, where A and B are constants. Show that the particles form a stable compound for $= \left(\frac{9B}{A}\right)^{1/8}$. prove that for stable configuration, the energy of attraction is 9 times the energy of repulsion. Also find the potential energy under stable configuration.

(6x2=12)

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

19. Explain Madelung energy and evaluate the Madelung constant for a one dimensional chain.
20. Discuss the origin of the quantization of spin waves.
21. What is dislocation and obtain the expression for the energy of dislocation.
22. What are Fick's laws? Obtain the solution for second Fick's law for the diffusion through a plane surface.

(2x5=10)

MSc PHYSICS DEGREE EXAMINATION

IV SEMESTER

Faculty of Science

PH810402 Science of Advanced Materials
(2019 admissions onwards)

Time: 3 hours Max. Weight:30

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

1. What are refractories? List their features.
2. What are semimetals?
3. What do you mean by dielectric breakdown?
4. Mention the properties of Gaussian beams.
5. Distinguish between temporal and spatial coherence.
6. List the features of photonic crystals.
7. Compare SLED and ELED.
8. What is nucleation?
9. What the natures of thin films?
10. Write a note on cathodic sputtering.

(8x1=8)

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

11. Compare thermoplastic and thermosetting polymers.
12. The tensile strength of 2 PMMA materials are 50MPa and 150MPa. Their respective number average molecular weight in g/mol are 30,000 and 50,000. Estimate the tensile strength at a number average molecular weight of 40,000 g/mol.
13. Show that the photovoltage varies logarithmically with photocurrent.
14. Find the ratio of populations of the two states in a laser that produces a wavelength of 590nm at room temperature.
15. An acousto-optic cell of Raman Nath modulator contains water. A piezoelectric crystal generates an acoustic wave of frequency 5MHz in water. The velocity of the acoustic wave in water is 1500m/s and the thickness of the cell is 1cm. If a laser beam of 632nm is incident on the cell,calculate the angle between the first order diffracted beam and the direct beam.

16. Discuss the classification of liquid crystals.
17. Differentiate between type I and type II superconductors.
18. Explain Josephson tunnelling.

(6x2=12)

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

19. Discuss the mechanical properties of ceramics.
20. How does mode locking be different from Q-switching? How are they achieved?
21. Explain the solar cell principles and characteristics.
22. Analyse the electrodynamics of superconductors.

(2x5=10)

MSc PHYSICS DEGREE EXAMINATION

IV SEMESTER

Faculty of Science

PH810403 Nanostructures and Materials Characterisation

(2019 admissions onwards)

Time: 3 hours Max. Weight:30

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

1. Write a note on quantum dots.
2. What are super lattices?
3. Explain self-assembly.
4. What are the advantages of nanosensors?
5. Why does graphene be important in nanoworld?
6. Distinguish between bathochromic and hypsochromic shifts.
7. What are the features of thermal lens spectroscopy?
8. State and explain Moseley's law.
9. Define amu and daltons.
10. Why are the applications of TGA more limited than those for DSC?

(8x1=8)

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

11. Discuss the various steps involve d in a CVD process.
12. Briefly explain the nanolithographic techniques.
13. Describe the features of giant and colossal magnetoresistance.

14. Discuss the size effects in nanostructures.
15. If the molar absorptivity of a complex is 12000 $lmol^{-1}cm^{-1}$ and the minimum detectable absorbance is 0.001, find the minimum molar concentration that can be detected for 1cm path length.
16. What are the advantages of Fourier transform spectrometry?
17. What is the short wavelength limit of the continuum produced by an X-ray tube having silver target and operated at 90kV?
18. An AFM cantilever has a spring constant 0.1N/m. Find its mass if oscillating frequency is 40kHz.

(6x2=12)

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

19. Discuss the theory of quantum leak.
20. Explain the properties and applications of nano ZnO and TiO_2.
21. (a) Explain how the photoluminescence power is related to concentration. (b) How does the fluorescence lifetime be calculated?
22. Analyse the functioning of TEM and how can you use TEM for quantitative analysis.

(2x5=10)