M.Sc I Physics

II

(11)

ગુજરાત યુનિવર્સિટી

ન.એકેડેમિક/બી/૧૨૮૯૯૯/૯૯:
ગુજરાત યુનિવર્સિટી કાર્યાલય,
અમદાવાદ-૯ તા.૩૦-૬-૧૯૯૯:

પરિપત્ર : ૬૫

યુનિવર્સિટી સાથે સંલગ્ન વિજ્ઞાન વિદ્યાભવનોનાં અધ્યક્ષશ્રી અને ફીઝીકસ વિષયના અનુસ્નાતક કેન્દ્રોના વડાઓને જણાવવાનું કે, એમ.એસસી. ભાગ-૧, નો ફીઝીકસ વિષયનો અભ્યાસક્રમ આ સાથેની પરિશિષ્ટ મુજબ સુધારવામાં આવ્યો છે, જેનો અમલ જૂન-૧૯૯૯ થી કરવાનો રહેશે.

પ્રતિ,

કુલસચિવ

૧: અધ્યક્ષશ્રી,
વિજ્ઞાન વિદ્યાભવન,
ગુજરાત યુનિ.અમદાવાદ-૯

૨: હેડ ઓફ ડીપાર્ટમેન્ટ,
ફીઝીકસ વિભાગ,
ગુજરાત કોલેજ, એલિસબ્રીજ,
અમદાવાદ

૩: હેડ ઓફ ડીપાર્ટમેન્ટ
ફીઝીકસ વિભાગ,
જે.વી.એમ.જે કોલેજ ઓફ સાયન્સ,
નડિયાદ

૪: પરીક્ષા નિયામકશ્રી,
પરીક્ષા વિભાગ,
ગુજરાત યુનિ.અમદાવાદ-૯

૫: શ્રીમતી પ્રફુલ્લાબેન ત્રિવેદી,
પરીક્ષા વિભાગ,
ગુજરાત યુનિવર્સિટી,
અમદાવાદ-૯

વાધેલા : ૩૦.૬.

M.Sc. Part I Syllabus for Physics

Effective from June 1999

PAPER I

(i) Mathematical Physics :

Functions of a complex variable

1. Introduction
2. Analytic functions
3. Contour Integrals
4. Laurent series
5. Residue theorem
6. Methods of finding residues
7. Evaluation of definate integrals
8. The point at infinity, residues at infinity
9. Mapping
10. Some applications of conformal mapping

Integral transforms

1. Introduction
2. Laplace transforms
3. Solution of differential equations by Laplace transform
4. Convolution
5. Inverse lapiace transforms

Text for (i) and (ii) Mathematical methods in the physical sciences by M.L.Boas

Group theory

8.1. Group, subgroups and classes
8.2. Invarient sub groups, factor groups
8.3. Homomorphism and Isomorphism
8.4. Group representation
8.5. Reducible and irreducible representation
8.6. Schur's Lemmas, orthogonality theorem
8.7. Character of a representation, character tables
8.8. Decomposing a reducible representations into irreducible ones
8.9. Construction of representation
8.10. Representations of groups and quantum mechanics
8.11. Lie groups and Lie algebra
8.12. The three dimensional rotational group (SO3)
8.13. The special unitary groups SU2, SU3
(a) The homomorphism between SU2 and SO3
(b) The irreducible representation of SU2
(c) Representation of SO3 from those of SU2
(d) The generators of unitary groups
(e) The group SU3
8.14. Some application of group theory in physics

Ref: Mathematical Physics by P.K.Chattopadhyaya

Integral equations and Green's functions

1. Introduction
2. Conversion of differential equation into an integral equation
3. Linear Harmonic oscillator
4. Liouville-Newman series separation methods

Ref: Mathematical methods for Physicist by G.Arfken

6.1. Non homogeneous boundary value problems and Green's functions
6.2. Green's functions for one dimensional problems
6.3. Eigen function expansion of Green's function
6.4. Fourier transforms method of constructing the Green's functions
6.5. Green's functions in higher dimensions
6.6. Green's functions for Poission's equation and a formal solution of electrostatic boundary value problem
6.7. Wave equation with a source

Ref: Mathematical Physics by P.K.Chattopadhyaya, Wiley Eastern Ltd.

Tensors

2.1. Introduction
2.2. n - dimentional space
2.3. Superscript and subscript
2.4. Coordinate transformation
2.5. Indicial summation convention
2.6. Dummy and Real indices
2.7. Chronekar and symbol
2.8. Scalars. contravarient vectors and convarient vectors
2.9. Tensors of higher rank
2.10. Algebraic operations
2.11. Symmetric and Antisymmetric tensors
2.12. Invarient tensors
2.13. Conjugate and reciprocal tensors
2.14. Relative and absolute tensors
2.15. Line element and matric tensor
2.16. Fundamental tensors
2.17. Raising and lowering of indices
2.18. Length of orthogonality of vectors
2.19. Christofell's C-index
2.20. Transformation laws for Christofell's symbols
2.21. Geodesics
2.22. Covarient differentiation of vectors
2.23. Covarient differentiation of tensors of higher rank
2.24. Covarient derivative of fundamental tensors
2.25. Laws of covarient differentiation
2.27. Tensors form of grad, div ∇^2, and cure
2.28. Div. of a tensor
2.29. Intrinsic derivatives
2.30. Geodesic coordinates
2.31. Riemann christofells tensors
2.32. Covarient curvature tensor and its properties
2.33. The number of algebrically independent components of the

. curvature tensor
2.34. Contraction of Reimann - Christofells's tensor
2.35. Vianchi indentities
2.36. Contraction of Viancni identity
2.37. Simple application of tensor to non relativistic physics

(4) Quantum Mechanics

Approximation Methods for stationary states

5.1. Perturbation theory for descrete levels. Equations in various orders in perturbation theory
5.2. The non-degenerate state
5.3. The degenerate case. removal of degeneracy
5.4. The effect of an electric field on the energy levels of the atom (The stark effect)
5.5. Two electron atoms

The variation method

5.6. Upper bound on ground state energy
5.7. Applications to excited states
5.8. Trial function linear in variational parameters
5.9. The hydrogen molecule
5.10. Exchange interaction

W.K.B. Approximation

5.11. The one dimensional Schrodinger equation
5.12. Bohr-Sommerfeld quantum condition
5.13. W.K.B.Solution of the radial wave equation

Evolution with time

Exact formal solutions " Propagators
9.1. Schrodinger equation, general solution
9.2. Propagators
9.4. Alteration of Hamiltonian. transition and sudden approximation

Ref: Textbook of Quantum Mechanics' by Mathews and Vanketesan

10.3. Description in terms of one electron Green's function

Ref: Solid State theory by W.A.Harrison TMH)

2. Einstein's Quantum theory of radiation

2.1. Einstein - Coefficients
2.2. Momentum transfer
2.3. Life time
2.4. Possibility of amplification

3. Interaction of radiation with matter

3.1. Time dependent perturbation theory
3.2. Electric dipole interaction
3.3.1. Creation and annihilation operators
3.3.2. Fock states
3.3.3. Quantization of the field
3.3.4. Zero point energy
3.3.5. Coherent state description of electromagnetic field
3.3.6. The interaction of radiation with matter

Ref: Lasers and Non linear optics by B.B.Laud
New Age International

Alternative picture of time evolution

9.16. The Schrodinger picture : transformation to other pictures
9.17. The Heisenberg picture

(iii) Programming in C

1. Overview of C

1.1. Introduction
1.2. Importance of C
1.3. Sample C programs
1.4. Basic structure of C programs
1.5. Programming style
1.6. Executing a "C" program
1.7. Points to remember

2. Constants, Variables and Data types

2.1. Introduction
2.2. Character set
2.3. C tokens
2.4. Constants
2.5. Keywords and identifiers
2.6. Variables
2.7. Data types
2.8. Declaration of variables
2.9. Assigning values to variables
2.10. Defining symbolic constants

3. Operators and Expressions

3.1. Introduction
3.2. Arithmetic operators
3.3. Relational operators
3.4. Logical operators
3.5. Assignment operators
3.6. Increment and decrement operators
3.7. Conditional operator
3.8. Bitwise operators
3.9. Special operators

3.10. Arithmetic expressions
3.11. Evaluation of expressions
3.12. Procedure of Arithmetic operators
3.13. Some conceptutional problems
3.14. Type conversions in expressions
3.15. Operator precedence and associativity
3.16. Mathematical functions case studies

4. Managing Input and Output operations

4.1. Introduction
4.2. Reading a character
4.3. Writing a character
4.4. Formatted Input
4.5. Formatted output case studies

Textbook: Programming in C by E.Balagursamy
Tata McGraw-Hill Pub.Co. New Delhi

PAPER II

(a) Classical Mechanics
(b) Orbital Mechanics
(c) Electrodynamics
(d) Plasma Physics
(e) Statistical Mechanics

(a) Classical Mechanics

(i) Euler's angles (ii) Motion of a symmetric top

Canonical transformation and Hamilton Jacoby theory. Gauge transformation. Canonical transformation, condition for transformation to be canonical, illustration of canonical transformations. oission bracket. canonical equations in terms of Poission brackets notation. Infinitesimal small transformations, Relation between infinitesimal small transformation and Poission brackets. The Hamilton Jacoby equation. Separation of variables. Action angle variables, Properties of action angle.

Non-linear oscillations and chaos

10.1. Introduction
10.2. Singular points of trajectories
10.3. Non-linear oscillations, volterra's problem
10.4. Limit cycles
10.5. Chaos

Ref: Introduction to Classical Mechanics by Takwale and Puranik TMH

Classical Mechanics by H.Goldstein. Addision Wesley

Classical Mechanics by A.B.Bhatia. Narosa Pub.Co. Ch.10

(b) Orbital Mechanics

Solar system, celestial sphere, spherical triangle, Horizontal, equatorial ecliptic and galactic coordinate system. Circumpolar star, sidereal time Many body problem, integrals of many body system, formulation of two body problem, elliptic orbit solution of Keplers equation by different methods, parabolic orbit, Numerical problem related to the motion of artificial satellites and heavenly bodies, orbital elements. Determination of orbital elements from position and velocity.

Ref: Text book on spherical Astronomy, by Smart W.M. Cambridge Univ. Press

Introduction to orbital mechanics by Geyling F.T. and Westerman, Adission-Wesley Pub. Co.

Introduction to Cellestial Mechanics by McSusky S.W. Adission Wesley

(c) Electrodynamics

Electromacnetic radiation

9.1. Dipole radiation
9.2. Radiation from a point charge
9.3. Radiation reaction

Electrodynamics and Relativity

10.2. Relativity Mechanics
10.3. Relativistic electrodynamics
10.14. Structure of space time

Ref: Introduction to electrodynamics by Griffith's Prentice Hall India Ltd.

Scattering and Dispersion

11.1. Scattering of radiation by a free charge
11.2. Scattering of radiation by a bound charge
11.3. Radiation damping
11.4. Dispersion in dilute gases
11.5. Dispersion in liquids and solids
11.6. Media contains free electrons

Ref: Electromagnetics by B.B.Laud, Wiley Eastern

(d) Plasma Physics

Hydrodynamic description of plasma

5.1. The moment equations
5.2. Derivation of the moment equations
5.3. Magnetohydrodynamics OR MHD
5.3.1. One fluid model
5.3.2. Two fluid model

B.B.G.K.Y. Equations

6.1. Collisions
6.2. Liouvillel equation
6.3. The system of B.B.G.K.Y. Equations
6.4. The B-V equation with self consistent field

Applications of Plasma

7.1. Controlled thermonuclear Reaction
7.1.1. Lawson Criterion
7.1.2. The Conlomb Barrier
7.1.3. Heating and Confinement of plasma
7.1.4. Radiation loss of energy
7.1.5. Instability problem
7.2. Magnetohydrodynamic conversion of energy
7.3. Plasma propulsion
7.4. Other plasma devices

Ref: Introduction to Plasma Physics by F.F.Chen, Plenum Press

(e) Statistical Mechanics

Tune dependence of Fluctuations

6.1. Power spectrum of Fluctuation
6.2. Persistance and correlation of fluctuation
6.3. Wiener-Khinching theorem
6.4. Johnson noise - Nyquist theorem
6.5. Shot noise
6.6. Fokker - Planck equation

Imperfact gases and gas condensation

11.1. Van der Walls equation
11.2. 2nd Virial coefficient
11.3. General virial coefficient and cluster diagrams
11.4. Gas-Liquid condensation

Cooperative phase transition

12.1. Cooperative processes
12.2. Brugg - Williums approximation
12.3. Comparison with experiments near the transition temperature
12.4. Ising problem and its solution for a linear chain

12.5. Series expansion method for the 3-dimensional Ising problem
12.6. Estimation of thermodynamic quantities

Ref: Statistical Mechanics and Properties of Matter by E.S.R.Gopal MacMillan

PAPER III

SECTION I

Energy Bands

Nearly Free Electron Model :

Origin of energy gap, Magnitude of the energy gap. Bloch Functions, Kronig-Penney Model

Wave Equation of Electron in a Periodic Potential :

Restatement of the Bloch theorem, crystal momentum of an electron, solution of the central equation, empty lattice approximation, Approximate solution Near and Zone Boundary. Effective mass of an electron.

Number of orbitate in Band: Metals and insulators

Fermi Surfaces and Metals:

Reduced zone scheme, Periodic zone scheme, construction of Fermi surfaces. Electron orbits, Hole orbits nd open orbits.

Calculations of energy bands:

Tight Binding Method for energy bands, Wigner - Seitz Method, APW method, OPW and pseudopotential, cohesive energy.

Experimental methods in Fermi Surface studies :

Quantization of orbits in a Magnetic field, De-Haas-Van Alphen Effect. Extremal orbits, Fermi Surface of copper, Magnetic Breakdown.

Optical Properties:

Introduction, Drude model, Macroscoppic theory of optical constants, Dispersion and Absorption, Imperfections, Colour centres, Excitons

Superconductivity:

Type I and Type II superconductors, critical currents, Landon Equation. Thermodynamics of superconducting transition. Origin of energy gap, Frohlich interaction, cooper pair, coherence length, phase coherence and flux quartization, Josephson tunnelling, BCS theory, High Tc superconductivity.

Ref: Introduction to Solid State Physics by C.Kittle
Wiley Eastern Limited. New Delhi

Solid State Physics by C.M.Kachhava
Tata McGraw Hill Pub.Co. Ltd., New Delhi

Solid State Physis by A.J.Dekker
Macmillan and Co. Ltd. Bombay

SECTION II (ELECTRONICS)

Power Amplifiers:

Class A large signal amplifiers. second harmonic distortion, the transformer coupled audio power amplifier. efficiency. puch pull amplifier, Class B amplifiers

Oscillators:

RC Phase Shift Oscillator, RC Wien Bridge oscillator (with analysis). Transistor as a switch. transistor switching times. Relaxation oscillator, Multivibrators - astable, monostable and bistable. Schmidt trigger circuit.

Microwave Generators:

Klystron, magnetron and travelling wave tube. Solid State devices - Gunn diode and Impatt diode.

Power Supplies:

Derivation for stabilization factor and output resistance for zener shunt regulator. transistor shunt and series regulator and feedback regulators, current limiting in power supply.

Field Effect Transistors:

Introduction, advantages and disadvantages of the FET, & basic construction. characteristics curves of FET, principles of operation, effect of VDs on channel conductivity, Channel ohmic region and Pinch off region, characteristic parameters of FET. effect of temperature on FET parameters. Common source AC emplifier. Fixed bias with self bias. common drain amplifier.

common gate amplifier, frequency response of the FET amplifier.

TTL Circuits:

Digital integerated circuits, 7400 Devices. TTL parameters. TTL overview, AND - OR - INVERT gates. open collector gates. three state TTL devices, external drive for TTL loads, TTL driving external loads, positive and negative logic.

Operational Amplifiers:

Characteristics of an ideal OPAMP, block diagram of OPAMP, differential amplifiers, Rejection of common mode signals. constant current replacement for RE. The DC level shifter, A complimentrary output stage, The operational amplifier, input and output impedances. Input off-set voltage, input offset current.

Ref.Books

1. Integrated Electronics by Millman and Halkias, International Students Edition
2. Electronic fundamental and Applications by John D.Ryder, Prentice Hall
3. Electronic Devices and Circuits by Allen Mottershed, Prentice Hall
4. Microwaves by K.C.Gupta, Wiley Eastern Ltd.
5. Handbook of Electronics by Gupta and Kumar, Pragati Prakashan, Merut
6. Electronic Devices and Circuits by Y.N.Bapat, Tata McGraw Hill Publishing Co. New Delhi.
7. Digital Principles and applications by Malvino and Leach, Tata McGraw Hill Edition

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PAPER III

SECTION III (SOLID STATE ELECTRONIC DEVICES)

ELECTRICAL CONDUCTION IN SEMI CONDUCTORS

Crystal. Electron energy levels in crystals. Band theory, Insulators, conductors, Semiconductors, Electons and Holes. Mobility, P – and N-type semiconductors. generation and recombination

ELECTRONS AND HOLES IN SEMICONDUCTORS

The density of states in an Energy band, Energy state densities in semi conductors and the effect of temperature. Intrinsic semiconductor. N-type semiconductor. P-type semiconducter, Variation of Fermi level with temperature. The law of mass action, Mobile and immobile charges, The Hall effect.

JUNCTION BETWEEN MATERIALS

Work function in a metal, Junction between metals, Semiconducter Junctions with no applied voltage, semiconductor junction with applied voltage, Junction Capacitance, Flow of current across a P N junction the rectifier equation, The breakdown region of a P N junction.

BOOK

1. Transistors by Denis Le Croissette
Prentice Hall of India Pub. 1965

List of Experiments at M.Sc. Part I Physics

1. Hall mobility and Hall angle.
2. Ionic conductivity in alkali harlides.
3. Determination of Band gap of semiconductor by studying its photoconductivity.
4. Resistivity of a semiconductor by four probe method.
5. Lattice dynamics.
6. Thermoluminance of alkali halides.
7. Piezo electrtric effect.
8. Zeeman effect.
9. To study the absorption band spectrum of I_2 molecule.
10. To find efficiency of a G.M.Counter.
11. Find absorption coefficient of β particles of Aluminium.
12. Determination of velocity of sound in liquids using ultrasonic interferometer.
13. To study the performance of a vacuum pump and verify Gaedes equation.
14. Determination of OPAMP parameter.
15. To study universal gates (NAND and NOR).
16. To study a phase shift oscillator.
17. To study Wien's Bridge oscillator.
18. To study Astable multivibrator.
19. To study electronically regulated power supply.
20. To study FET amplifier.