SYLLABUS

MANONMANIAM SUNDARANAR UNIVERISTY, TIRUNELVELI-12

PG - COURSES – AFFILIATED COLLEGES
Course Structure for

M.Sc. Physics

(Choice Based Credit System)
(With effect from the academic year 2017- 2018 onwards)

Semester-IV				
Part	**Subject Status**	**Subject Title**	**Subject Code**	**Credit**
3	Core	Quantum Mechanics II	PPHM41	4
3	Core	Spectroscopy	PPHM42	4
3	Core	Nuclear and Particle Physics	PPHM43	4
3	Practical	Advanced Physics Experiments II	PPHL41	2
3	Practical	C++ Programming	PPHL42	2
3	Elective	Field Work	PPHT41	3
3	Core	Project	PPHP41	8

QUANTUM MECHANICS II

Preamble:

The course provides knowledge on the theory of angular momentum, various approximation methods, and theory of scattering and relativistic quantum theory. The various aspects studied in the course quantum mechanics I is essential. This course is capable of solving many problems that cannot be exactly solved.

Unit I:

Theory of angular momentum

Orbital angular momentum – Eigen pairs of L2 and Lz – Properties of components of L and L2 – Matrix representation of L2, Lz and L± - spin state of an electron – spin orbit coupling – Addition of angular momenta.

Unit II:

Approximation Methods I

Time Independent Perturbation Theory: Introduction- Theory for non-degenerate case - Application to non-degenerate levels- Theory for degenerate levels- First order Stark effect in Hydrogen atom.

Unit III:

Approximation Methods II

Time Dependent Perturbation Theory:Introduction- Transition probability- constant perturbation-Harmonic perturbation- adiabatic perturbation- sudden approximation- Semi classical theory of radiation- calculation of Einstein coefficients.

Unit IV:

Scattering theory

Classical scattering cross section – Centre of mass and laboratory co-ordinate systems – Scattering amplitude – Green's function approach – Born approximation – Partial wave analysis – Scattering form a square well system.

Unit V :

Relativistic Quantum Theory

Klein – Gordon equation – Dirac equation for a free particle – Spin of a Dirac particle – Particle in a potential – Relativistic particle in a box – Relativistic hydrogen atom – Electron in a field – Spin orbit energy.

Books for Study:

1. Quantum Mechanics I: Fundamentals- S. Rajasekar and R. Velusamy (CRC Press, Taylor and Francis group- Boca Raton, London)

Books for Reference:

1. Quantum Mechanics - L. Schiff- Third Edition (Tata Mc-Graw Hill, New Delhi)

2. A Text Book of Quantum Mechanics- P. M. Mathews and K. Venkatesan (Tata McGraw Hill, New Delhi, 1987)
3. Quantum Mechanics - S. Devanarayanan (Sci. Tech. Publications Pvt Ltd, Chennai, 2005)
4. Quantum Mechanics- G. Aruldhas (Prentice Hall of India, New Delhi, 2003)

SPECTROSCOPY

Preamble:

This course gives detailed knowledge about various types of spectroscopy. The structure of different chemical compounds can be determined by studying these types.

Unit I

Microwave Spectroscopy

Classification of molecules based on moment of inertia – rotational spectra of rigid and non-rigid diatomic molecules – Isotopic effect – linear polyatomic molecule - symmetric top molecule – chemical analysis –microwave spectrometer.

Unit II

Infrared Spectroscopy

Vibrating diatomic and poly-21atomic molecules – Simple harmonic oscillator – anhormonicity – Hydrogen bonding – Fermi resonance – rotation vibration spectra of polyatomic molecule – information from IR spectra – IR spectrometer – FTIR.

Unit III

Raman Spectroscopy

Theory of Raman scattering – rotation vibration Raman spectra – mutual exclusion principle – Raman spectrometer – polarization of Raman scattered light – structure determination using Raman spectrum – phase transition – resonance Raman scattering.

Unit IV

Resonance Spectroscopy

Magnetic properties of nuclei – resonance condition – relaxation time – Chemical shift – application to molecular structure – Bloch equation – NMR instrumentation – NMR imaging – ESR theory and hyperfine structure ESR spectra of hydrogen atom and anisotropic systems – crystal defects and biological studies – ESR spectrometer.

Unit V

Surface spectroscopy

Electron Energy Loss Spectroscopy EELS – Reflection – absorption IR spectroscopy RAIRS – Surface Enhanced Raman Scattering SERS – Inelastic Helium Scattering – X-Ray Photoelectron Spectroscopy XEPS.

Book for Study:

1. N.Banwell and E.M.Mc Cash, Fundamentals of Molecular Spectroscopy, Tata McGraw Hill.
2. G.Aruldhas, Molecular Structure and Spectroscopy, Prentice Hall India.

Book for Reference:

1. B.P.Strughan and S.Walker, Spectroscopy, John Wiley.
2. Peter J.Larkin, IR and Raman Spectroscopy Principle and Spectral Interpretation, Elsevi

NUCLEAR AND PARTICLE PHYSICS

Preamble:

This course imparts knowledge about the elementary particles, nuclear structure, nuclear reactions with the help of various nuclear models.

Unit I

Nuclear Forces

Ground and excited states of deuteron – magnetic dipole and electric quadrupole moments of deuteron – n-p scattering at low energies – shape independent effective range theory of np scattering – pp scattering at low energies – exchange forces –meson theory of nuclear force.

Unit II

NuclearDecays

Gamow'stheory of alpha decay – lineand Continuous spectrum of β decay- Fermi theory of beta decay – Fermi and Gamow-Teller selection rules – parity violation – Gamma decay – multipole transitions in nuclei – selection rules – internal conversion – nuclear isomerism.

Unit III

Nuclear Models

Liquid drop model – Weizsackers mass formula – nuclear stability – Bohr Wheeler theory of nuclear fission -magic numbers -evidence for magic numbers – shell model – spin orbit coupling – angular momenta and parities of nuclear ground states – magnetic moments - Schmidt line – collective model.

Unit IV

Nuclear Reactions

Types of nuclear reactions – Q-equation – solution of the equation – compound nuclear theory – reciprocity theorem – nuclear cross section – resonance scattering– Breit –Wigner dispersion formula – nuclear chain reaction – four factor formula.

Unit V

Elementary Particles

Classification of elementary particles- fundamental interactions conservations laws – CPT theorem - SU(3) multiplet – meson octet – baryon octet and baryon decouplet – Gellmann-Okubo mass formula - Quark theory.

Books For Study:

1. Nuclear Physics, D. C. Tayal, Himalaya Publications.
2. Elements of Nuclear Physics, M. C. Pandia and R. P. S. Yadav Kedarnath.

Books For Reference:

1. Concepts of Nuclear Physics, Bernard L Cohen, Tata Mc Graw-Hill
2. Nuclear Physics an Introduction, S. B. Patel, Wiley Eastern Ltd.
3. Nuclear Physics, R. R. Roy and B. P. Nigam, New Age International Ltd.

Advanced Physics Experiments II

Preamble:

It is expected to provide hands on experience in understanding the advanced physics experiments Hall effect, Hysteresis, Ultrasonic diffraction etc… Basic skills and knowledge about the experiments is required. The theory behind the experiments is also studied.

Any FIVE Experiments

1. **Temperature co-efficient and Band Gap**
   Determination of Temperature co-efficient and band gap of a given Semiconductor Thermistor using Carey-Foster Bridge.

2. **Hall Effect**
   a. Definition of Hall effect and its application
   Determination of
   b. Hall voltage
   c. Hall coefficient
   d. Carrier density
   e. Mobility of charge carriers
   f. Resistivity

3. **Four Probe**
   a) Four Probe principle
   b) Measurement of Resistivity and Energy band gap of a given semiconductor material
   c) Measurement of Resistivity of a large sample using Four Probe mapping.

4. **Ultrasonic Diffraction**
   Formation of acoustic grating in a given liquid using a crystal to determine the velocity of ultrasonic wave in the liquid and compressibility of the liquid.
   Repeat for another liquid and hence find the ratio of compressibility and velocity.

5. **LCR circuit**
   a) Determination of dielectric constant of a liquid using LCR circuit
   b) Determination of dielectric constant of a given crystal using LCR meter.

6. **Hysteresis**
   Formation and tracing of magnetic hysteresis loop for the given specimen to determine
   a) Coercivity
   b) Retentivity and

c) Energy loss per unit volume per cycle of the specimen

7. Two Probe
   Determination of resistivity of the given samples

C++ Programming

Preamble:

The course provides knowledge about the C++ programming and the course is able to solve many tedious physical problems numerically.

Any FIVE programs Algorithm and Flow chart

1. **Curve Fitting – Fitting a straight line.**
   a) Principle of least Square and fitting a straight line.
   b) Principle of linear interpolation
   c) C++ program to fit a straight line using the data obtained from Cauchy's Constant Experiment and Interpolation using the fitted equation

2. **Solution of simultaneous equations - Gauss Elimination method.**
   a) Procedure to solve Simultaneous equations using Gauss Elimination Method
   b) Solving unknown branch currents in Wheatstone's bridge using GE method manually.
   c) C++ program to solve the equations.

3. **Numerical Differentiation**.
   a) Derivation of Exponential law of Radioactive decay.
   b) RK 4th order method of solving a given 1st order differential equation.
   c) Analytical computation of the mass of the given radioactive sample after a specified period (Given: activity or half life period).
   d) C++ program using RK method to solve radio-active problem – Compare output with the analytical result.

4. **Area under the Curve**
   a) Numerical integration – derivation of Simpson's rule
   b) C++ programs for Simpson 1/3rd rule, Simpson 3/8 rule and
   c) Montecarlo integration.
   d) Comparison of the program output with direct integration.

5. **Eigen Value and Eigen Vector**.
   a) Explanation of Eigen Values and Eigen Vectors.
   b) Calculation of Eigen Values and Eigen Vectors using analytical method.
   c) C++ program to calculate Eigen values and Eigen vectors of a give matrix – Comparison with analytical result.

6. **Matrix Multiplication**
    a) Multiplication of given matrices
    b) Rotation matrix definition.
    c) C++ program to rotate the given point about the origin using rotation matrix by the given angle.

7. **Numerical Differentiation**
    a) Numerical differentiation – related to any physical problem
    b) Derivation of Newton's law of cooling – equation
    c) C++ program to verify the Newton's law of cooling from the given experimental data.

8. **Solution of Algebraic and Transcendental equations**.
    a) Solution of the given equations using Newton Raphson Method – manual calculation.
    b) C++ program to find the solution using N-R method and verification.

PROJECT

GUIDELINES FOR PROJECT WORK

Format for Preparation of Project Report for M.Sc., Physics

1. **Arrangement of Contents:**

The sequence in which the project report material should be arranged and bound should be as follows:

Cover Page & Title Page
Bonafide Certificate
Abstract
Table of Contents
List of Tables
List of Figures
List of Symbols, Abbreviations and Nomenclature
Chapters
Appendices
References

2**. Page Dimension and Binding Specifications**:

The dimension of the project report should be in A4 size. The project report should be bound using flexible cover of the thick white art paper. The cover should be printed in black letters and the text for printing should be identical.
Total number of Pages should not exceed 70.

3**. Preparation Format**

Cover Page & Title Page – A specimen copy of the Cover page & Title page of the

project report are given in Appendix 1.

Bonafide Certificate –

The Bonafide Certificate shall be in double line spacing using Font Style Times New Roman and Font Size 14.

The Certificate shall carry the supervisor's signature and shall be followed by the supervisor's name, academic designation (not any other responsibilities of administrative nature), department and full address of the institution where the supervisor has guided the student. The term 'SUPERVISOR' must be typed in capital letters between the supervisor's name and academic designation.

Preface – Preface should be one page synopsis of the project report typed double line spacing, Font Style Times New Roman and Font Size 14.

Table of Contents – The table of contents should list all material following it as well as any material which precedes it. The title page and Bonafide Certificate will not find a place among the items listed in the Table of Contents but the page numbers of which are in lower case Roman letters. One and a half spacing should be adopted for typing the matter under this head.

List of Tables – The list should use exactly the same captions as they appear above the tables in the text. One and a half spacing should be adopted for typing the matter under this head. The tables shall be introduced in the appropriate places in the text.

List of Figures – The list should use exactly the same captions as they appear below the figures in the text. One and a half spacing should be adopted for typing the matter under this head. The figures shall be introduced in the appropriate places in the text.
List of Symbols, Abbreviations and Nomenclature – One and a half spacing should be adopted or typing the matter under this head. Standard symbols, abbreviations etc., should be used.
Chapters – The Chapters may be broadly divided into 5 parts
1. Introduction to Project
2. Literature Survey
3. Methods and methodology/Working / Experimental Techniques
4. Result Analysis
5. Conclusion

1. The main text will be divided into several chapters and each chapter may be further divided into several divisions and sub-divisions.
2. Each chapter should be given an appropriate title.
3. Tables and figures in a chapter should be placed in the immediate vicinity of the reference where they are cited.
4. Footnotes should be used sparingly. They should be typed single space and placed directly underneath in the very same page, which refers to the material they annotate.

Appendices – Appendices are provided to give supplementary information, which is included in the main text may serve as a distraction and cloud the central theme.
1. Appendices should be numbered using numerals, e.g. Appendix 1, Appendix 2, etc.
2. Appendices, Tables and References appearing in appendices should be numbered and referred to at appropriate places just as in the case of chapters.
3. Appendices shall carry the title of the work reported and the same title shall be made in the contents page also.

List of References –The listing of references should be typed 4 spaces below the heading "REFERENCES" in alphabetical order in single spacing left – justified. The reference material should be listed in the alphabetical order of the first author. The name of the author/authors should be immediately followed by the year and other details.
A typical illustrative list given below relates to the citation example quoted above.

References

1. Ariponnammal, S. and Natarajan, S. (1994) „Transport Phonomena of Sm Sel – X Asx", Pramana – Journal of Physics Vol.42, No.1, pp.421-425.
2. Barnard, R.W. and Kellogg, C. (1980) „Applications of Convolution Operators to Problems in Univalent Function Theory", Michigan Mach, J., Vol.27, pp.81–94.
3. Shin, K.G. and Mckay, N.D. (1984) „Open Loop Minimum Time Control of Mechanical Manipulations and its Applications", Proc.Amer.Contr.Conf., San Diego, CA, pp. 12311236.

Table and figures - By the word Table, is meant tabulated numerical data in the body of the project report as well as in the appendices. All other non-verbal materials used in the body of the project work and appendices such as charts, graphs, maps, photographs and diagrams may be designated as figures.

4. **Typing Instructions**

The impression on the typed copies should be black in colour. One and a half spacing should be used for typing the general text. The general text shall be typed in the Font style „Times New Roman" and Font size 14.