राज ऋषि भर्तृहरि मत्स्य विश्वविद्यालय, अलवर

Raj Rishi Bhartrihari Matsya University, Alwar

RAJ RISHI BHARTRIHARI UNIVERSITY, ALWAR

M.Sc. Physics
(Annual Scheme)

SCHEME OF EXAMINATION
(Annual Scheme)

Each Theory Paper	3 hrs. duration	100 Marks
Dissertation / Thesis/Survey Report/Field Work, if any		100 Marks

1. The number of papers and the maximum marks for each paper / Practical shall be shown in the syllabus for the subject concerned. It will be necessary for a candidate to pass in theory part as well as in the Practical part (Wherever prescribed) of a subject/paper separately.
2. A candidate for a pass at each of the Previous and the Final Examination shall be required to obtain (i) atleast 36% marks in the aggregate of all the papers prescribed for the examination and (ii) atleast 36% marks in practical (s) wherever prescribed at the examination, provided that if a candidate fails to secure atleast 25% marks in each individual paper at the examination, and also in the test dissertation/Survey report/Field Work, wherever prescribed, he shall be deemed to have failed at the examination notwithstanding his having obtained the minimum percentage of marks required in the aggregate for that examination. No division will be awarded at the Previous Examination. Division shall be awarded at the end of the Final Examination on the combined marks obtained at the Previous and the Final Examinations taken together, as noted below:

First Division	60%	Of the aggregate marks taken together of the
Second Division	48%	Previous and the Final Examinations.

All the rest will be declared to have passed the examination.

3. If a candidate Clears any Paper (s) / Practical (s) / Dissertation prescribed at the Previous and/or Final examination after a continuous period of three years, then for the purpose of working out his division the minimum pass marks only viz. 25% (36%in the case of practical) shall be taken into account in respect of such Paper (s) I Practical (s) I Dissertation as are cleared after the expiry of the aforesaid period of three years; provided that in case where a candidate requires more than 25% marks in order to reach the minimum aggregate as many marks out of those actually secure by him will be taken into account as would enable him to make up the deficiency in the requisite minimum aggregate.
4. The Thesis/ Dissertation/ Survey/ Report/ Field Work shall typewritten and submitted in triplicate so as to reach the office of the Registrar atleast 3 weeks before the commencement of the theory examination. Only such candidates shall be permitted to offer Dissertation/ Field Work/ Survey /Report/ Thesis (If provided in the scheme of Examination) in lieu of a paper as have secured atleast 55% marks in the aggregate of all the paper prescribed for the previous examination in the case of annual scheme irrespective of the number of paper in which a candidate actuall' appeared at the examination.

N.B.-Non-Collegiate candidates are not eligible to offer disseration as per provisions of 0.170- A.

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PHYSICS

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अकादमिक-प्रथम

प्राचार्य
गौरीदेवी राजकीय महिला महाविद्यालय
अलवर (राज॰)

RAJ RISHI BHARATRIHARI UNIVERSITY

ALWAR

SYLLABUS

ANNUAL SCHEME

M.Sc. (Final) PHYSICS

2018-19

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M.Sc. (Final) Physics

PAPER -V : ADVANCED QUANTUM MECHANICS AND INTRODUCTORY QUANTUM FIELD THEORY

Max.Marks :100 Duration : 3hrs.

Note: Five questions are to be set. Question first will consist of ten short answer type questions and is compulsory. Remaining four questions will be from four units one from each unit (each question will have an internal choice). Student will attempt all the five question 40% weightage will be given to problems and numericals

UNIT - I

Scattering (non-relativistic): Differential and total scattering cross-section ,partial wave analysis, solution of scattering problem by the method of partial wave analysis, expansion of a plane wave into a spherical wave and scattering amplitude, the optical theorem, Applications.- scattering from a delta potential, square well potential and the hard sphere scattering of identical particles, energy dependence and resonance scattering. Breit-Wigner formula, quasi stationary states. The Lippman-Schwinger equation and the Green's function approach for scattering problem, Born approximation and its validity for scattering problem, Coulomb scattering problem under first Born approximation in elastic scattering.

Relativistic Formulation and Dirac Equation: Attempt for relativistic formulation of quantum theory, The Klein-Gordon equation, Probability density and probability current density, solution of free particle KG equation in momentum representation, interpretation of negative probability density and negative energy solutions.

UNIT - II

Dirac equation for a free particle, properties of Dirac matrices and algebra of gamma matrices, non-relativistic correspondence of the Pauli equation (inclusive of electromagnetic interaction). Solution of the free particle. Dirac equation, orthogonality and completeness relations for Dirac spinors, interpretation of negative energy solution. Symmetries of Dirac Equation : Lorentz covariance of Dirac equation, proof of covariance and derivation of Lorentz boost and rotation matrices for Dirac spinors, Projection operators involving four momentum and spin, Parity (P), Charge. conjugation(C), time reversal (T) and CPT operators for Dirac spinors, Bilinear covariants, and their transformations behaviour under Lorentz transformation, P,C,T and CPT, expectation values of coordinate and velocity, involving only, positive energy solutions and the associated problems, inclusion of negative energy solution, Zitter bewegung, Klein paradox.

UNIT - III

The Quantum Theory of Radiation : Classical radiation field, transversality condition, Fourier decomposition and radiation oscillators, Quantization of radiation oscillator, creation, annihilation and number operators; photon states, photon as a quantum mechanical excitations of the radiation field, fluctuations and the Uncertainty relation, validity of the classical description, matrix element for emission and absorption, spontaneous emission in the-dipole approximation, Rayleigh scattering. Thomson scattering and the -Raman effect, Radiation damping and Resonance fluorescence. Scalar and vector fields: Classical Lagrangian field theory, 'Euler-Lagrange's equation, Lagrangian density for electromagnetic field. Occupation number representation for simple harmonic oscillator, linear array of coupled oscillators. Second quantization ,of identical bosons, second quantization of the real Klein Gordan field and complex ,Klein-Gordan field, The occupation number representation for fermions, second quantization of the Dirac filed.

UNIT – IV

Path integral, theory of propagator, meson propagator, the fermion propagator.
The electromagnetic interaction and gauge invariance, covariant quantization of the electromagnetic field, the photon propagator.
S-matrix: the S-matrix expansion, Wick's theorem, Diagrammatic representation in configuration space, the momentum representation, Feynman diagrams of basic processes, Feynman rules of QED.
Applications of S .matrix formalism: the Coulomb scattering, Bhabha scattering, Moller scattering, Compton scattering and pair production.

Reference Books :

1. Ashok Das and A.C. Millissiones : Quantum Mechanics -A Modern Approach.(Garden and
Breach Science Publishers)
2. E. Merzbaker : Quantum Mechanics, Second Edition (John Wiley and sons)
3. Bjorken and Drell : Relativistic Quantum Mechanics (MGraw Hill)
4. J.J. Sakuri : Advanced Quantum Mechanics (John Wiley)
5. F. Mandal & G. Shaw, Quantum Field Theory (John Wiley)
6. J,M. Ziman, Elements of Advance Quantum Theory, (Cambridge University Press)
7 Lectures on quantum field theory Ashok Das (World Scientific press).

PAPER - VI : NUCLEAR PHYSICS

Max.Marks : 100 Duration : 3hrs.

Note: Five questions are to be set. Question first will consist of ten short answer type questions and is compulsory. Remaining four questions will be from four units one from each unit (each question will have an internal choice). Student will attempt all the five question 40% weightage will be given to problems and numericals

UNIT - I

Nucleon-Nucleon Scattering and Potentials : Partial wave analysis of the neutron-proton scattering at low energy assuming central potential with square well shape, concept of the scattering length, coherent scattering of neutrons by protons in (ortho and para) hydrogen molecule; conclusions of these analyses regarding scattering lengths, range and depth of the potential; the effective range theory (in neutron-proton scattering) and the shape independence of nuclear potential; A qualitative discussion of proton scattering at low energy: General features of two-body scattering at high energy Effect of exchange forces: Phenomenological Hamada-

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Johnston hard core potential and Reid hard core and soft core potentials; Main features of the One boson Exchange Potentials (OBEP) no derivation.

Two Nucleon system and Nuclear Forces: General nature of the force between nucleons, saturation of nuclear forces, charge independence and spin dependence, General forms of two nucleon interaction, central, non-central and velocity dependent potentials, Analysis of the ground state (3S1)of deuteron using a square well potential, range-depth relationship, excited states of deuteron, Discussion of the ground state of deuteron under non-central force, calculation of the electric quadrupole and magnetic dipole moments and the D-state admixture.

UNIT – II

Nuclear shell model: Single particle and collective motions in nuclei: Assumptions and justification of the shell model, average shell potential, spin orbit coupling; single particle wave functions and level sequence; magic numbers; shell model predictions for ground state parity; angular momentum, magnetic dipole and electric-quadrupole moments; and their comparison with experimental data; configuration mixing; single particle transition probability according to the shell model; selection rules; approximate estimates for the transition probability and Weisskopf units: Nuclear isomerism. Collective nuclear models: Collective variable to describe the the cooperative modes of nuclear motion; Parametrization of nuclear surface; A brief description of the collective model Hamiltonian (in the quadratic approximation); Vibrational modes of a spherical nucleus, Collective modes of a deformed even-even nucleus and moments of, inertia; Collective spectra and electromagnetic transition in even nuclei and comparison with experimental data; Nilsson model for the single particle states in deformed nuclei.

UNIT – III

Interaction of radiation and charged particle with matter (No derivation): Law of Absorption and attenuation coefficient; Photoelectric effect, Compton scattering, pair production; Klein-Nishima cross sections for polarized and un-polarized radiation, angular distribution of scattered photon and electrons, Energy loss of charged particles due to ionization, Bremstrahlung; energy target and projectile dependence of all three processes, Range-energy curves; Straggling. Nuclear Reactions: Theories of Nuclear Reactions; Partial wave analysis of reaction Cross section; Compound nucleus formation and breakup, Resonance scattering and reaction- Breit- Wigner dispersion formula for S-waves (l= 0), continuum cross section; statistical theory of nuclear reactions, evaporation probability and cross section for specific reactions; The optical model, Stripping and pick-up reactions and their simple theoretical description (Butler theory) using plane wave Born approximation (PWBA) Short comings of PWBA nuclear structure studies with deutron stripping (d,p) reactions.

UNIT - IV

Nuclear gamma and beta decay: Electric and magnetic multipole moments and gamma decay probabilities in nuclear system (no derivations),Reduced transition probability, Selection rules; internal conversion and zero. zero transition.

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General characteristics of weak interaction; nuclear beta decay and lepton capture, electron energy spectrum and Fermi- Kurie plot; Fermi theory of beta decay (parity conserved selection rules Fermi and Gammaw-Teler) for allowed transitions; ft-values; General interaction Hamiltonian for beta decay with parity conserving and non conserving terms; Forbidden transitions ,Experimental verification of parity violation; The V-A interaction and experimental evidence.

Experimental Techniques: Gas filled counters; Scintillator counter, Cerenkov counters; Solid state detectors; Surface barrier detectors; Electronic circuits used with typical nuclear detectors;

Multiwire proportion chambers; Nuclear emulsions, techniques of measurement and analysis of tracks; Proton synchrotron; Linear accelerations; Acceleration of heavy ions.

Reference Books :

1.J. M Blatt and V.E. Weisskipf: Theoretical Nuclear Physics

2. Statistical theory of nuclear reactions, Exaparation probability and cross section for specific
reaction.

3. L.R.B Elton: Introductory Nuclear Theory, ELBS Pub. London, 1959

4. B.K. Agrawl : Nuclear Physics, Lokbharti Pub, Allahabad. 1989

5. M.K. Pal: Nuclear Structlire, Affiliated East-West Press, 1982).

6. RR Roy and B.P.Nigam, Nuclear Pbysics, Willey-Easter, 1979

7. M.A. Preston & RK Bhaduri-Structure of the Nucleus, Addision Wesley, 1975

8. RM. Singru : Introductory Experimental Nuclear Physics

9. England - Techniques on Nuclear Structure (Vol.D

10. RD. Evans-TheAtomicNucleus(McGraw-Hills, 1955)

11. H. Enge -Introduction to Nuclear PeYsic~,Addition-Wesley, 1970

12. W.E.Burcham- Elementsof NuclearPhysics,ELBS, Longman, 1988

13. B.L. Cohen - Concpt of Nuclear Physics Tata Mc-Graw Hills, 1988

14. E. Segre - Nuclei, Particles Benjamin, 1977

15. I. Kaplan - Nuclear Physics, Addison Wesley, 1963

16. D. Hallidy - Introductory Nuclear Physics, Wiley, 1955.

17. Harvey - Introduction of Nuclear Physics and Chemistry

PAPER-VII: STATISTICAL AND SOLID STATE PHYSICS

Max.Marks :100 Duration : 3hrs.

Note: Five questions are to be set. Question first will consist of ten short answer type questions and is compulsory. Remaining four questions will be from four units one from each unit (each question will have an internal choice). Student will attempt all the five question 40% weightage will be given to problems and numericals.

UNIT - I

Basic Principles, Canonical and Grand Canonical ensembles: Concept of statistical

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distribution, phase space, density of states, Liouville's theorem, systems and ensemble, entropy in statistical mechanics Connection between thermodyanic and statistical quantities micro canonical ensemble, equation of state, specific heat and entropy of a perfect gas, using micro canonical ensemble. Canonical ensemble, thermodynamic functions for the canonical ensemble, calculation of mean values, energy fluctuation in a gas, grand Canonical ensemble, thermodynamic functions for the grand canonical ensemble, density fluctuations.

Partition functions and Statistics: Partition functions and Properties, partition function for an ideal gas and calculation of thermodynamic quantities, Gibbs Paradox, validity of classical approximation, determination of translational, rotational and vibrational contributions to the partition function of an ideal diatomic gas. Specific heat of a diatomic gas, ortho and para hydrogen. Identical particles and symmetry requirement, difficulties with Maxwell-Boltzmann statistics, quantum distribution functions.

UNIT-II

Bose-Einstein and Fermi-Dirac statistics, Boson statistics and Planck's formula, Bose Einstein condensation, liquid He as a Boson system, quantization of hannonic oscillator and creation and annihilation of Phonon operators,

quantization of fermion operators.

Band Theory: Block theorem, Kronig Penny model, effective mass of electrons, Wigner-Seitz approximation, NFE model, tight binding method and calculation of density for a band in simple cubic lattice, pseudo potential method.

Semiconductors: law of mass action, calculation of impurity conductivity, ellipsoidal energy surfaces in Si and Ge, Hall effect, recombination mechanism, optical transitions and Schockely- Read theory excitons, photoconductivity, photo-Luminescence. Points line, planar and bulk

defects, colour centres, F-centre and aggregate centres in alkali halides.

UNIT - III

Theory of Metals: Fermi- Dirac distribution function, density of states, temperature dependence of Fermi energy, specific heat, use of Fermi. Dirac statistics in the calculation of thermal conductivity and electrical conductivity, Widemann -Franz ratio, susceptibility, width of conduction band, Drude theory of light, absorption in metals. Lattice Vibrations and Thermal Properties: Interrelations between elastic constants C11, C12 and C44 wave propagation and experimental determination of elastic constant of cubic crystal, vibrations of linear mono and diatomic lattices, Determination of phonon dispersion by inelastic scattering of neutrons.

UNIT - IV

Magnetism: Larmor diamagnetism. Paramagnetism, Curie Langevin and Quantum theories. Susceptibility of rare earth and transition metals. Ferromagnetism: Domain theory, Veiss molecular field and exchange, spin waves: dispersion relation and its experimental determination by inelastic neutrons scattering, heat capacity. Nuclear Magnetic resonance: Conditions of resonance, Black equations. NMR-experiment and characteristics of an absorption line. Superconductivity: (a) Experimental results: Meissner effect, heat capacity, microwave and infrared properties, isotope effect, flux

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quantization, ultrasonic attenuation, density of states, nuclear spin relaxation, Giver and AC and DC, Josephson tunnelings. (b) Cooper pairs and derivation of BCS Hamiltonian, results of BCS theory (no derivation).

Reference Books:

1. Huag : Statistical Mechanics
2. Reif : Fundamentals of Statistical and Thermodynamical Physics
3. Rice : Statistical mechanics and Thermal Physics
4. Kittle: Elementary statistical Mechanics
5. Kittle : Introduction to Solid State Physics
6. Patterson: Solid State Physics
7. Levy : Solid State Physics
8. Mckelvy: Solid State and Semi-conductor Physics.

PAPER-VIII : (A) MICROWAVE ELECTRONICS

Max.Marks :100 Duration : 3hrs.

Note: Five questions are to be set. Question first will consist of ten short answer type questions and is compulsory. Remaining four questions will be from four units one from each unit (each question will have an internal choice). Student will attempt all the five question 40% weightage will be given to problems and numericals.

UNIT - I

Introduction to microwaves and its frequency spectrum, Application of microwaves.Wave guides: (a) Rectangular wave guides: Wave Equation & its solutions, TE&TM modes. Dominant mode and choice of wave guide Dimensions Methods of excitation of wave guide.

(b) Circular wave guide-wave equation & its solutions, TE, TM & TEM modes.

(c) Attenuation - Cause of attenuation in wave guides, wall current & derivation of attenuation constant, Q of the wave guide.

Resonators: Resonant Modes of rectangular and cylindrical cavity resonators, Q of the cavity resonators, Excitation techniques, Introduction to Microstrip and Dielectric resonators, Frequency meter.

UNIT - II

Farrites: Microwave propagation in ferrites, Faraday rotation, Devices employing Faraday rotation (isolator, Gyrator, Circulator). Introduction to single crystal ferromagnetic resonators, YIG tuned solid state resonators.

Microwave Measurement:

(a) Microwave Detectors: Power, Frequency, Attenuation, Impedance Using smith chart, VSWR, Reflectometer, Directivity, coupling using direction coupler.

(b) Complex permittivity of material & its measurement: definition of complex of Solids, liquids and powders using shift of minima method.

Microwave tubes: Space charge spreading of an electron beam, Beam focussing.

Klystrons: Velocity Modulation, Two Cavity Klystron, Reflex Klystron Efficiency of Klystrons. Magnetrons: types & description.

UNIT-III

Theoretical relations between Electric & Magnetic field of oscillations. Modes of oscillation & operating characteristics.

Gyrotrons: Constructions of different ,Gyrotrons,Field-Particle Interaction in Gyrotron.

(a) Avalanche Transit Time Device: Read Diode, Negative resistance of an avalanching p-n Junction diode IMPATT and TRAPATT Oscillator.

(b) Transferred Electron Device: Gunn effect, two valley, model, High field Dotrutins, Different Modes for Microwave generation.

(c) Passive Devices: Termination (Short circuit and matched terminations) Attenuator, phase changers, E&H plane Tees, Hybrid Junctions. Directional coupler.

.Parametric Amplifier: Varactor, Equation of Capacitance in Linearly graded & abrupt pn-junction. Manely Rowe relations, parametric up convertor and Negative resistance parametric amplifier,-use of circulator, Noise in parametric amplifiers.

UNIT -IV

Microwave Antennas: Introduction to antenna parameters, Magnetic Currents, Electric and magnet* current sheet, Field of Huygen's source, Radiation from a slot antenna, open end of a wave guide and Electromagnetic Horns. Prabolic reflectors, Lens antennas. Radiation fields of Microstrip wave guide, Microstrip wave guide, Microstrip antenna calculations, Microstrip design formulas.

Microwave Communication:

(a) LOS microwave systems, Derivation of LOS communication range, OTH microwave systems, Derivation of field strength of tropospheric waves, . Transmission interference and signal damping, Duct propagation.

(b) Satellite Communication: Satellite frequencies allocation, Synchronous satellites, Satellite orbits, Satellite location with respect to earth and look angle, earth coverage and slant range, Eclipse effect, Link calculation, Noise consideration, Factors affecting satellite communication.

Reference Books:

1. Electromagnetic waves & Radiating Systems: Jorden & Balmain.
2. Theory and application of microwaves by A.B. Brownwell & RE. Beam (McGraw Hill) .
3. Introduction to microwave theory by Atwater (McGraw Hill).
4. Principles of microwave circuit by G.C. Montgomery (Mc Graw Hill)
5. Microwave Circuits & Passive Devices by M.L. Sisodia and G.S. Raghuvanshi (New Age
International, New Delhi)
6. Foundations of microwave engineering by RE. Collin. (McGraw Hill).
7. Microwave Semiconductor Devices and their Circuit applications by H.A. Watson
8. Microwave by M.L. Sisodia and Vijay Laxmi Gupta. New Age, New Delhi.
9. Antenna Theory, Part-I by RE. Collin & EJ. Zucker (McGraw Hill, New York)
10.Microstrip Antennas by Bahl & Bhartiya (Artech House, Messachausetts)
11. Antenna Theory Analysis by C.A. Balanis Harper & Row. Pub. & Inc. New York.

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12. Antenna Theory Analysis by E.A. W01""(J. Willey & Sons)
13. Antenna Theory & Design by RS Elliott (LPHI Ltd. New Delhi)
14. Microwave electronics by RE Soohoo (Addisen Westey pubblic company.)
15.Microwave Active Devices, Vacuoums by M.L. Sisodia new Age International New Delhi.
16. Semiconductors & Electronics device by A. Barle vs (PHI, India).
17. Solid State physical electronics by A.Vanderziel, (PHI, India).
18. Hand book of microwave measurement Vol-II by M. Sucher & J.Fox (polytechnic Press,
New York).
19. Microwave devices & circuits by S.Y.Liao(PHI, India).
20. Microwave Principles by H.J. Reich (CBS).
21. Simple microwave technique for measuring the dielectric parameters of solids & their
powder by J.M. Gandhi, J.S. Yadav, J. of pure & applied physics Vol. 30, pp-427431, 1992

LIST OF EXPERIMENTS FOR M.Sc. FINAL

Scheme:
The examination will be conducted for two days, 6 hrs. each day. The distribution of themarks will be as Follows :
Marks
Two experiments-120
Viva-40
Record-40
Total-200
Minimum Pass Marks-72

LIST OF EXPERIMENTS (any eighteen) :
1. To determine half-life of a radio isotope using GM counter.
2. To study absorption of particles and determine range using at least two sources.
3. To study characteristics of a GM counter and to study statistical nature of radioactive decay.
4. To study spectrum of γ-particles using Gamma ray-spectrometer.
5. To calibrate a scintillation spectrometer and determine energy of γ-rays from an unknown source.
6. (a) To study variation of energy resolution for a NaI (T) detector.
(b) To determine attenuation coefficient (μ) for rays from a given source.
7. To study Compton scattering of X-rays and verify the energy shift formula
8. To study temperature variation of resistivity or a semi-conductor and to obtain band gap using four probe method.
9. To study hall effect and to determine hall coefficient.
10. To study the variation of rigidity of a given specimen as a function of the temperature.

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11. To study the dynamics of a lattice using electrical analogue.
12. To study ESR and determine g -factor for a given spectrum.
13. To determine ultrasonic velocity and to obtain compressibility for a given liquid.
14. Study, the characteristics of a Reflex Klystron and calculate the mode number, E.T.S. and transit time.,
15. Study the simulated L.C.R. transmission line (audio frequency) and to find out the value for and Zo experimentally from the graph.
16. Study the radiation pattern of a given Pyramidal horn by plotting it on a Polar graph paper. Find the Half power beam width and calculate its gain.
17. Find the dielectric constant of a given solid (Teflon) for three different lengths by using slotted section.
18. Find the dielectric constant of a given liquid (organic) using slotted section of K-band.
19. Verification of Braggs law using microwaves..
20. Determination of Dielectric Constant of a liquid by lecher wire.
21. Study of a Heat Capacity of Solids.
22. Study of lattice dispersion.