M.G.S. UNIVERSITY,

BIKANER

SYLLABUS

SCHEME OF EXAMINATION AND COURSES OF STUDY

FACULTY OF SCIENCE

M.Sc. PHYSICS

M.Sc. PREVIOUS EXAMINATION – 2021
M.Sc. FINAL EXAMINATION - 2022

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M.Sc. PHYSICS

M.Sc. Previous Examination, 2021

M.Sc. Final Examination, 2022

M.Sc. (PREVIOUS) PHYSICS - 2021

Scheme of examination :

Four Theory Papers			Max. Marks 300
Practical			Max. Marks 150
Paper-I :	Mathematical Physics and Classical Mechanics	3 hrs. duration	75 marks
Paper-2 :	Statistical Mechanics and Plasma physics	3 hrs. duration	75 marks
Paper-3 :	Quantum Mechanics	3 hrs. duration	75 marks
paper-4 :	Electronic Devices, Computational Methods and Programming	3 hrs. duration	75 marks
Practical :	Two laboratory each	5 hrs. duration 150 marks	(75+75)

Note: There will be one experiment of 5 hrs. duration. The distribution of marks will be as follows:

One experiment	40
Viva	20
Record	15
Total	75

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A candidate for pass the M.Sc. (Previous) Physics examination shall be required to obtain at least 36% marks in aggregate both in four theory papers and practical separately. Apart from that candidate shall be required to obtain at least 25% marks in each individual theory paper.

If a candidate clears any paper (s) / practical after a continuous period of three years, than for the purpose of working out his/ her division, the minimum pass marks only viz 25% in case of theory (or 36% in case of practical) shall be taken into account in respect of such paper (s)/ practical.

Note: Non-collegiate candidates are not eligible to appear in the examination where practical is involved.

Work load: Each theory paper must be given 4 Hrs. (Or 6 periods) per week for theory and 1 pds per week for theory tutorial.

Practical must be given 30 periods per week per batch. Each laboratory batch for practical must not be of more than 10 students. This gives 120 Hrs. for each theory paper with 30 weeks of teaching every year.

PAPER-I :

MATHEMATICAL PHYSICS AND CLASSICAL MECHANICS

Time : 3 hrs. Max. Marks : 75

Note: The question paper shall contain three sections. **Section A** (**20 marks**) shall contain 10 questions two from each Unit. Each question shall be of **2** marks. All the questions are compulsory. The answers should not exceed 50 words. **Section B** (**25 marks**) shall contain 5 questions (two from each unit with internal choice). Each question shall be of **5** marks. The candidate is required to answer all 5 questions. The answers should not exceed 200 words. **Section C** (**30 marks**) shall contain 5 questions, one from each Unit. Each question shall be of **10** marks. The candidate is required to answer any three questions. The answers should not exceed 500 words.

UNIT-01

Vector Spaces and Matrices : linear independence; Bases; Dimensionality; Inner product; Linear transformations; Matrices; Inverse; Orthogonal and unitary matrices; Independent

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elements of a matrix; Eigenvalues and eigenvectors; Diagonalization; Complete Orthonormal sets of functions.

UNIT-02

Differential Equations and Special Functions; Second order linear ODEs with variable coefficients; Solution by series expansion; Legendre, Bessel, Hermite and Lagaurre equations; Physical application; Generating functions; recursion relations.

UNIT-03

Integral Transforms : Laplace transform; First and second shifting theorems; inverse LT by partial fractions; LT; derivative and integral of a function; Fourier series; FS or arbitrary period; Half-wave expansions; Partial sums; Fourier integral and transforms; F T of delta function.

Preliminaries; Newtonian mechanics of one and many particle systems; conservation laws, work-energy theorem; open systems (with variable mass).

Constraints; their classification, D'Alembert's principle, generalized coordinates. Lagrange's equations; gyroscopic forces; dissipative system; Gauge invariance; Invariance under Galilean transformations; generalized coordinates and momenta; symmetries of space and time with conservation laws; Jacobi integral; integrals of motion;

UNIT-04

Principle of least action; derivation of equations of motion; Hamilton's principle and characteristic functions.

Canonical transformation; generating functions; Hamilton-Jacobi equation Properties; group property; examples; infinitesimal generators; Poisson bracket; Poisson theorms; angular momentum in PB.

UNIT-05

Rotating frames; inertial forces; terrestrial and astronomical applications of coriolis force.

Central force; definition and characteristics; Two-body problem; closure and stability of circular orbits; general analysis of orbits; Kepler's laws and equation; artificial satellites; Rutherford scattering.

Text and Reference Books:

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Mathematical Methods for Physics, by G Arfken

Matrices and Tensors for Physicists, by A W Joshi

Advanced Engineering Mathematics, by E Kreyzing

Special Functions, by E D Rainville

Special Functions, by W W Bell

Mathematical Methods for Physics and Engineerings, by K F Reily . M

P Hobson and S J Bence

Mathematics for Physics, by Marry Boas

Classical Mechanics, by N.C. Rana and P.S. Joag (Tata McGraw-Hill, 1991)

Classical Mechanics, by H. Goldstein (Addison Wessley, 1980).

Mechanics, by A Sommerfeld (Academic Press, 1952).

Introduction to Dynamics, by I. Perceival and D. Richards (Cambridge University Press, 1982).

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PAPER-II :
STATISTICAL MECHANICS, ELECTRODYNAMICS AND PLASMA PHYSICS

Time : 3 hrs. Max. Marks : 75

Note: The question paper shall contain three sections. **Section A** (**20 marks**) shall contain 10 questions two from each Unit. Each question shall be of **2** marks. All the questions are compulsory. The answers should not exceed 50 words. **Section B** (**25 marks**) shall contain 5 questions (two from each unit with internal choice). Each question shall be of **5** marks. The candidate is required to answer all 5 questions. The answers should not exceed 200 words. **Section C** (**30 marks**) shall contain 5 questions, one from each Unit. Each question shall be of **10** marks. The candidate is required to answer any three questions. The answers should not exceed 500 words.

UNIT-01

Foundations of statistical mechanics; specification of states of a system, contact between statistics and thermodynamics, classical ideal gas, entropy of mixing and Gibb's paradox. Micro

canonical ensemble, phase space, trajectories and density of states, Liouville's theorem, canonical and grand canonical ensembles; partition function, calculation of statistical quantities, Energy and density fluctuation.

UNIT-02

Density matrix, statistics of ensembles, statistics of indistinguishable particles, Maxwell-Boltzman, Fermi-Dirac and Bose-Einstein statistics, properties of ideal Bose and Fermi gases, Bose-Einstein condensation.

Correlation of space-time dependent fluctuations, fluctuations and tranport phenomena, Brownian motion, Langevin theory, Fluctuation dissipation theorem. The Fokker-Planck equation.

UNIT-03

Cluster expansion for a classical gas, Virial equation of state, Ising model, mean-field theories of the Ising model in three, two and one dimensions Exact solutions in one-dimension. Landau theory of phase transition, critical indices, scale transformation and dimensional analysis.

Review of Four-Vector and Lorentz Transformation in Four-Dimensional Space, Electromagnetic Field Tensor in Four Dimension and Maxwell's Equations, Dual Field Tensor, Wave Equation for Vector and Scalar Potential and their Solutions.

UNIT-04

Retarded Potential and Lienard-Wiechart Potential, Electric and Magnetic fields due to a Uniformly moving Charge and an accelerated Charge, Linear and Circular Acceleration and Angular Distribution of power Radiated, Bramsstrahlung, Synchrotron radiation and Cerenkoy Radiation, reaction Force of Radiation.

Motion of charged Particles in Electromagnetic Field: Uniform E and B Fields, Non-uniform Fields, Diffusion Across Magnetic Fields, Time varying E and B Fields, Adiabatic Invariants: First, Second Third Adiabatic Invariants.

UNIT-05

Elementary Concepts; Derivation of moment equations from Boltzmann equation, Plasma oscillations, Debye Shielding, Plasma Parameters, Magnetoplasma, Plasma Confinement. Hydrodynamical description of Plasma Fundamental. Hydromagnetic Waves: Magnetosonic and

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Alfven Waves.

Wave phenomena in Magneto plasma: Polarization, Phase velocity, Group velocity, Cut-offs, Resonance for Electromagnetic Wave propagating Parallel and Perendicular to the Magnetic Field, Propagation at Finite Angle and CMA Diagram, Appleton-Hartee Formula and Propagation through Ionosphere and Magnetosphere: Helicon, Whistler, Faraday Rotation.

Text and Reference Books

Statistical and Thermal Physics, by F Reif

Statistical Mechanics, by K Huang

Statistical Mechanics, R K Pathria

Statistical Mechanics, R Kubo

Statistical Physics, Landau and Lifshitz

Panofsky and Phillips : Classical Electricity and Magnetism.

Bittencourt : Plasma Physics.

Chen : Plasma Physics.

Jackson : Classical Electrodynamics.

PAPER-III :
QUANTUM MECHANICS

Time : 3 hrs. Max. Marks : 75

Note: The question paper shall contain three sections. **Section A** (**20 marks**) shall contain 10 questions two from each Unit. Each question shall be of **2** marks. All the questions are compulsory. The answers should not exceed 50 words. **Section B** (**25 marks**) shall contain 5 questions (two from each unit with internal choice). Each question shall be of **5** marks. The candidate is required to answer all 5 questions. The answers should not exceed 200 words. **Section C** (**30 marks**) shall contain 5 questions, one from each Unit. Each question shall be of **10** marks. The candidate is required to answer any three questions. The answers should not exceed 500 words.

UNIT-01

Why Quantum Mechanics? Revision; Inadequacy of classical mechanics; Schrödinger

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equation; continuity equation; Ehrenfest theorem; Admissible wave function; Stationary states. One-dimensional problems, wells and barriers; Solution of Harmonic oscillator by Schrodinger equation and by operator method.

Uncertainty relation, x and p States with minimum uncertainty product, General formalism of wave mechanics, Commutation relations, Representation of states and dynamical variables.

UNIT-02

Completeness of eigenfunctions; Dirac delta function; bra and ket notation; Matrix representation of an operator; Unitary transformation.

Angular momentum in Quantum Mechanics; Addition of angular momentum, CG coefficient, Wigner-Eckart theorem, Central force problem; Solution of Schrödinger equation for spherically symmetric potentials; application in Hydrogen atom.

UNIT-03

Time-independent perturbation theory; Non-degenerate and degenerate cases; Applications Stark effect, Zeeman effect (normal and anomalous).

Time-dependent perturbation theory; Harmonic perturbation; Fermi's golden rule; Adiabatic and sudden approximations. Semi classical theory of radiation; Transition probability for absorption and induced emission; Electric dipole and forbidden transitions; Selection rules.

UNIT-04

Variational method; Helium and its excited states, WKB approximation; Alpha decay Identical particles; Symmetric and antisymmetric wave functions; collision of identical particles; Spin angular momentum; Spin functions for a many-electron.Klein-Gordan and Dirac’s equation.

UNIT-05

Collision in 3-D and scattering; Laboratory and reference frames; Scattering amplitude; differential scattering cross section and total scattering cross section; Scattering by spherically symmetric potentials; Partial wave analysis and phase shifts; Scattering by a perfectly rigid sphere and by square well potential; complex potential and absorption.Born approximation

Text and Reference Books

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L.I. Schiff, Quantum Mechanics (McGraw-Hill)

S. Gasiorowicz, Quantum Physics (Wiley)

B Craseman and J.D. Powell, Quantum Mechanics (Addison Wesley)

A.P. Messiah, Quantum Mechanics

J.J. Sakurai, Modem Quantum Mechanics

Mathews and Venkatesan Quantum Mechanics

PAPER-IV : ELECTRONIC DEVICES,

COMPUTATIONAL METHODS AND PROGRAMMING

Time : 3 hrs. Max. Marks : 75

Note: The question paper shall contain three sections. **Section A** (**20 marks**) shall contain 10 questions two from each Unit. Each question shall be of **2** marks. All the questions are compulsory. The answers should not exceed 50 words. **Section B** (**25 marks**) shall contain 5 questions (two from each unit with internal choice). Each question shall be of **5** marks. The candidate is required to answer all 5 questions. The answers should not exceed 200 words. **Section C** (**30 marks**) shall contain 5 questions, one from each Unit. Each question shall be of **10** marks. The candidate is required to answer any three questions. The answers should not exceed 500 words.

UNIT-01

Transistors : JEET, BIT, MOSFET, and MESFET : Structure, Working, Derivations of the equations for I-V characteristics under different conditions. High frequency limits.

Photonic Devices ; Radiative and non-radiative transitions. Optical Absorption, Bulk and Thin film Photoconductive devices (LDR), diode photodetectors, solar cell (open circuit voltage and short circuit current, fill factor). LED (high frequency limit, effect of surface and indirect recombination current, operation of LED),

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UNIT-02

Memory Devices : Static and dynamic random access memories, SRAM and DRAM, CMOS and NMOS, non-volatile—NMOS, magnetic, optical and ferroeletric memories, charge coupled devices (CCD).

Other Electronic Devices: Electro-Optic, Magneto-Optic and Acousto-Optic Effects. Material Properties related to get these effects. Important Ferro electric, Liquid Crystal and Polymeric materials for these devices. Piezoelectric,

UNIT-03

Electrostrictive and magneto strictive effects, Important materials exhibiting these properties, and their applications in sensors and actuator devices. Acoustic Delay lines, Piezoelectries resonators and filters. High frequency piezoeelectric devices-Surface Acoustic Wave Devices.

Sources of errors, Round off, errors, Computer arithmetic, error analysis, condition and stability, Appoximations.

Solution of linear and nonlinear equations: Direct, iterative, Bisection method, Newton's method, modified Newton's method.

UNIT-04

Interpolation: The method of undetermined coefficients, Finite differences, Newton's, Gauss's Central difference and Stirling's Formulae, Lagrange's Interpolation Formulae, Double interpolation.

Methods of integration: Method of integration for a system of equation and functions, error estimates, Trapezoidal and Simpson's rules, Newton-Cotes formulae, Gaussian Integration, Singular Integrals, Generalised Quadrature, Double Integration.

UNIT-05

Numerical differentiation by Newton's Forward, backward formula; By Stirling Formula, Numerical solution of ordinary differential equations by Taylor's series method, Euler and Runge-Kutta methods.

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Elementary information about Digital computer Principles, Compilers, Interpreters and Operating systems, Fortran77/C programming, Flow Charts Integer and Floating Point Arithmitic, Expressions, built in functions, executable and non-executable statements assignment, control and input- output elements Subroutines and functions, Operation with files. Introduction to MATLAB.

Text and Reference Books

Semiconductor Devices-Physics Technology, by SM Sze (Wiley 1985)

Introduction to semiconductor devices, by M.S. Tyagi, John Wiley & Sons

Measurement, Instrumentation and Experimental Design in Physics and Engineering by M. Saver and A. Mansingh. Prentice Hall, India (2000)

Optical electronics by Ajoy Ghatak and K. Thyaearajan. (Cambridge Univ. Press)

Shastry : Introductory Methods of Numerical Analysis

Rajaraman : Numerical Analysis, Rajaraman : Fortran Programming

Vetterming, Teukolsky, Press and Flannery : Numerical Recipes

PRACTICALS

LIST OF EXPERIMENTS :

Number of experiments to be performed by the students during the academic session should be atleast eight from each Laboratory.

Laboratory A General

1. To determine e/m by Thomson Method.
2. To determine e/m by Helical Method.
3. To analyze Elliptically Polarized light by Babinet's Compensator.
4. To verify Fresnel's Relations using prism and spectrometer.
5. To determine the Young's Modulus of rod using Cornu's Optical Method.
6. To determine e/m by Millikan's oil Drop method.
7. To determine Resolving Power of a Telescope.

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8. To plot B-H Hysteresis curve using a solenoid on CRO and study it.
9. To determine velocity of Sound in Air by Standing Wave Method.
10. To determine the Magnetic Susceptibility of a Paramagnetic salt using Quinke's method .
11. To study Energy Transfer between Coupled Oscillators.
12. To use a Michelson Interferometer to determine :
    a. λ,-the wave length of Sodium yellow light
    b. $(\lambda_1 - \lambda_2)$, the difference between the wave length of the two sodium D-lines. (iii) the thickness of a mica sheet.
13. To test the validity of the Hartmann's prism dispersion formula using the visible region of mercury spectrum.
14. To find the refractive index of air by means of a Fabry-Perot Etalon, the thickness between the plates being given.
15. Determination of wave length of Neon light taking Hg source as a standard source Appling Hartmann formula.
16. Determine Stefan's constant.
17. X-ray diffraction by Telexometer.
18. Determination of ionization potential of Lithium.
19. Determination of e/m of electron by Normal Zeeman Effect.
20. Determinations of dissociation energy of Iodine (I) molecules by photography, the absorptions band of I in the visible region.
21. Using He-Ne laser light :
    a. Measure of wavelength with the help of ruler. (b) Measure of thickness of the wire.
22. Testing goodness of fit of Poisson distribution to cosmic ray busts by Chi-square test.
23. To study Faraday effect using He-Ne laser.

Laboratory B - Electronic

1. To Study Mathematical Operations using OPAMP.
2. To study OPAMP as Comparator using Inverting and Non-inverting configuration
3. To study Clipping and Clamping circuits.
4. To study Differentiating and Integrating circuits using diode.

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5. To study Miller Sweep Generator.
6. To study Bootstrap Sweep Generator.
7. To study the Recovery Time of Diode.
8. To study Free-running Multivibrator.
9. To study Mono- and Bi-stable Multivibrator circuits.
10. To study RC coupled Two-Stage Amplifier.
11. Design of a Regulated Power supply.
12. Design of a Common Emitter Transistor Amplifier.
13. Experiment on Bias Stability
14. Characteristics and applications of Silicon Controlled Rectifier.
15. Experiment on FET and MOSFET characterization and application as an amplifier.
16. Experiment on Uni-junction Transistor and its application.
17. Digital I : Basic Logic Gates, TTL, NAND and NOR.
18. Digital II: Combinational logic.
19. Flip-Flops.
20. Operational Amplifier (741)
21. Differential Amplifier.

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