K.K. UNIVERSITY

NALANDA, BIHAR - 803115

School of Applied Sciences

Master of Physics (M.Sc.)

(Two Years Full Programme)

2022-2023

SCHEME OF EXAMINATION

&

DETAILED SYLLABUS

Pro Vice Chancellor
KK University
Berauti, Nepura, Bihar Sharif
Nalanda - 803115 (Bihar)

M.Sc. (Physics)Course Structure

Year	Semester	Course Code	Course Title	L	T	P	C
1ST		MSPH-18101	Mathematical Physics	3	1	0	4
		MSPH-18102	Atomic,Molecular& Laser Physics	3	1	0	4
		MSPH-18103	Analog& Digital Electronics	3	1	0	4
		MSPH-18104	Quantum Mechanics	3	1	0	4
		MSPH-18105	Condensed Matter Physics	3	1	0	4
		MSPH-18106	Relativity& Plasma Physics	**3**	**1**	**0**	**4**
		MSPH-18107	Practical optics	0	0	16	8
		MSPH-18108	Practical Electronics	0	0	16	8
2ND		MSPH18201	Nuclear Physics	3	1	0	4
		MSPH18202	Statistical Mechanics	3	1	0	4
		MSPH18203	Computational Physics and Microprocessor	3	1	2	4
		MSPH18204	Solid state physics-I	3	1	0	4
		MSPH18205	Solid state physics-II	3	1	0	4
		MSPH18206	Practical Digital Electronics & Microprocessor	**0**	**0**	**12**	**6**
		MSPH18207	Practical-Communication Electronics	0	0	12	6
		MSPH18208	Project &Dissertation	0	0	16	8

Course of Dissertation:-

- ✓ **Digital Electronics & Microprocessor**
- ✓ **Semi-Conductor Physics**
- ✓ **Condensed Matter Physics**
- ✓ **Electronics**

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MSPH18101 -MATHEMATICAL PHYSICS

L	T	P	Cr
3	**1**	0	**4**

RATIONALE
Physics is the language of Mathematics. Without Mathematics, it is impossible to learn physics.This course deals with different aspects of Mathematical Physics like Complex Variables, Differential Equations, Integral Transform, Fourier Series and Fourier Transform.

UNITS	CONTENTS	Contact Hrs.
I	**Complex Variables:** Introduction, Cauchy-Riemann conditions, Polar &Cartesion form, Cauchy's Integral formula, Laurent expansion, Singularities, Calculus of residue, Evaluation of definite integrals like $\int_0^{2\pi} f(Sin\theta, Cos\theta)d\theta, \int_{-\infty}^{\infty} f(x)e^{-iax}\, dx$	**10**
II	**Differential Equations:** Partial differential equations of theoretical physics, Separation of variables, Series solutions. **Special Function:** Bessel functions of first and second kind, Generating function, Integral representation and recurrence relations for Bessel's functions of first kind, orthogonality; Legendre functions: generating function, Recurrence relations and special properties, Orthogonality	**12**
III	**Integral Transform:** Laplace transform, I^{st} and II^{nd}shifting theorem, Inverse Laplace transform ,Laplace transform of derivatives and integral of functions and solutions of initial value problem.	**08**
IV	**Fourier Series and Fourier Transforms:** Fourier series, Dirichlet conditions. General properties. Advantages and applications, Gibbs phenomenon, Fourier transforms, Development of the Fourier integral, Fourier transforms of derivatives. Momentum representation. **Tensors:** Scalar, Vector and tensor quantities, Contravariant and covariant tensors, Metric tensor, addition, Multiplication and contraction of tensors, Application of tensors in coordinate transformations.	**10**

REFERENCE BOOKS :		
1.	Mathematical Methods for Physicists	Arfken G. and Weber H.J
2.	Mathematical Physics	Rajput B. S
3.	Mathematical Methods in the Physical Sciences	Boas M.L. John Wiley & Sons, NewYork (1983).
4.	Mathematical Physics	H.K.Das

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MSPH-18102 ATOMIC, AND MOLECUL& LASER PHYSICS

L	T	P	Cr
3	1	0	4

RATIONALE
Atomic and molecular Physics is basically the study of science of atom and molecules. This course will cover all necessary aspects of atoms and molecules.

UNITS	CONTENTS	Contact Hrs.
I	**One Electron Atom:** Vector model of a one electron atom, Quantum states of an electron in an atom, Hydrogen atom spectrum, Spin-orbit coupling, Relativistic correction, Hydrogen fine structure, Spectroscopic terms, Hyperfine structure	10
II	**Two valance Electron Atom:** Vector model for two valance electrons atom, LS coupling, Pauli exclusion principle, Interaction energy for LS coupling, Lande interval rule, jj coupling, interaction energy for jj coupling.	10
III	**Atom in Magnetic Field:** Zeeman effect, Magnetic moment of a bound electron, Magnetic interaction energy in weak field. Paschen-Back effect, Magnetic interaction energy in strong field. **Atom in Electric Field:** Stark effect, First order Stark effect in hydrogen.	8
IV	**Molecular Spectroscopy:** Rotational and vibrational spectra of diatomic molecule, Raman Spectra, Electronic spectra, Born-Oppenheimer approximation, Vibrational coarse structure, Franck-Condon principle, Rotational fine structure of electronic-vibration transitions. **Spin Resonance Spectroscopy:** Electron spin resonance and nuclear magnetic resonance spectroscopy.	12

REFERENCE BOOKS :

1.	Introduction to Atomic Spectra	White H. E.,
2.	Fundamentals of molecular spectroscopy	Banwell C. N. and McCash E. M.,
3.	Atomic and molecular Physics	Rajkumar
4.	Application of Raman spectroscopy	Hendra, P.C.John's& G. Waenns

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MSPH18103 - ANOLOG & DIGITAL ELECTRONICS

L	T	P	Cr
3	1	0	4

RATIONALE
This syllabus covers logic system, digital system, microprocessor etc. are significant in the course for practical knowledge.

UNITS	CONTENTS	Contact Hrs.
I	**Logic Systems:** Basic Concepts of dc positive and negative logic systems, Dynamic Logic Systems. Brief introduction to Boolean Algebra/Logic gates (OR, AND, NOR, NAND, EX-OR, etc.), K mapping.	8
II	**Digital Systems:** Standard gate assemblies. Binary Address, Parallel and Serial operations, Half Adder, Full Adder, J-K Flip-flop, Shift Register, Up and Down Counters, Synchronous and Asynchronous counters, Bipolar and MOS digital systems and their comparison, Decoder, Multiplexer Encoder, Encoder, Read Only Memory, Random Access Memory, Applications of ROM and RAM, Digital Display, Seven segment display, Sequence generator. Memory Storage cell (both Bipolar and MOS RAM), Read, Write and Address operations (both Bipolar and MOS RAM), Digital to Analog Converters, Weighted resistor and 2R Ladder type, Analog to digital Converters.	10
III	**Microprocessor:** An Introduction to Microprocessor, Microcomputers and assembly language. Bus interfacing, Bus organised computers, SAP-1, SAP-2 and SAP-3, Machine language, ASCII code. 8085 Microprocessor architecture, Microprocessor initiated operations. Internal data operations, 8085, 8086, 8087 registers, Externally initiated operations, Memory mapping and memory classification. Simple microcomputer system, Logic devices for interfacing. Microprocessor communication and bus timings. 8085 machine cycles. Memory interfacing with 8085. Interfacing I/O devices, Introduction to 8085 assembly language programming. 8085 instruction. General purpose programmable Peripheral devices. Microprocessor Applications, Recent trends in Microprocessor Technology. Introduction to 8086 microprocessor and 8051 microcontroller.	12
IV	**Laboratory Assignments:** To study Analog to Digital converter (ADC) and Digital to Analog converter (DAC). Multiplexer and Demultiplexer circuits. 4-bit Shift register. D, SR and JK Flip Flops. 4-bit comparator. Ripple up and down counter. Encoder and decoder. Perform arithmetic operations using 8085 microprocessor. Arithmetic operations using 8086 microprocessor. Study the 4-bit shift register and observing the output using CRO. Seven segment display (IC trainer). Use of an operational amplifier for various mathematical operations. To perform Boolean Algebra using AND, OR, NOT, XOR gates. Construct and verify the operation of a Half adder, Full Adder and Substractor. Study of 8051 microcontroller.	10

REFERENCE BOOKS :		
1.	Digital Systems-Principles and Applications	Tocci R. J
2.	Microprocessor Architecture, Programming & Applications	Gaonkar R. S
3.	Digital Computer Electronics	Malvino A.P
4.	Introduction to Microprocessors	Mathur A.P

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MSPH18104 - QUANTUM MECHANICS

L	T	P	Cr
3	1	0	4

RATIONALE
This course deals with different concepts of quantum Physics. The students will learn about Schrödinger wave Equation, Angular Momentum and Perturbation theory.

UNITS	CONTENTS	Contact Hrs.
I	**Introduction to Quantum mechanics:** Experimental background and inadequacy of classical Physics, Photoelectric Effect, Compton effect, Pair production and Pair Annihilation, wave particle duality and uncertainty principle, Complimentary principle.	**8**
II	**Schrödinger wave Equation:** Development of wave equation, Schrodinger's time dependent and independent wave equation, Interpretation and normalization of wave function, Probability current density, Expectation value and Ehrenfest theorem. Wave packets, Momentum Eigen functions, Box normalization and delta function. **Solution of Schrödinger's equation:** Sectionally constant potential in one dimension: Potential Step, Rectangular Potential Barrier and tunneling, The square potential well. Potential with bounded states: Linear Harmonic Oscillator, Rigid Rotator and Hydrogen atom.	**12**
III	**Angular momentum in Quantum mechanics:** General solution to the Eigen value problem of angular momentum J and the angular momentum matrices, Eigenvectors for spin ½ particles, addition of two angular momenta.	**08**
IV	**Perturbation theory:** Time independent perturbation theory: (1) Non degenerate case: First order perturbation, second order perturbation, Perturbation of an oscillator. (2) Degenerate case: Removal of degeneracy in second order, Zeeman Effect without electron spin, first order Stark effect in Hydrogen	**12**

REFERENCE BOOKS :

Quantum Mechanics	Schiff L. I McGraw-Hill (2008)
Quantum Mechanics	Ghatak&Loknathan MacMillan India Ltd (2004)
Advance Quantum Mechanics	Satya Prakash
Quantum Mechanics	Sakurai J.J Addison Wesley (1967).

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MSPH-18105 CONDENSED MATTER PHYSICS

L	T	P	Cr
3	1	0	4

RATIONALE
Condensed matter Physics is largely concerned with crystals and their structures. This syllabus covers Crystal structure, Lattice Vibrations and thermal properties etc.

UNITS	CONTENTS	Contact Hrs.
I	**Crystal Structure:** Fundamental types of lattices-two and three dimensional lattice types, SC, BCC and FCC unit cells, Miller indices, Diffraction of x-rays by crystals, Scattered wave amplitude-Fourier analysis, Reciprocal lattice vectors, Diffraction conditions, Laue equations, Structure factor and Atomic form factors.	8
II	**Lattice Vibrations and Thermal Properties:** Vibration of lattice with monoatomic and diatomic basis: Dispersion relation, optical and acoustical branches. Quantization of elastic waves: Phonon, Classical theory of Specific heat. Average energy of harmonic oscillator, Phonon Density of states. Einstein and Debye models of specific heat.	10
III	**Concept of Energy Band:** Nearly free electron model and origin of energy gap, magnitude of gap, Bloch function, Kroning - Penny model, Classification of metal, insulator and semiconductors. Wave equation of electron in periodic potential, Bloch theorem and crystal momentum, Kronning-Penny model in reciprocal space, Brillouin zones. **Dielectrics:** Dielectric properties of insulators, Types of polarizations, Local fields , Claussius-Mosotti equation, Dielectric constant and loss, Introduction to piezo, Pyro, Ferroelectric materials	10
IV	**Magnetism:** Types of magnetism, Susceptibility, Permeability and their relation. Diamagnetism: Langevin Quantum theory of Diamagnetism. Paramagnetism: Quantum Theory, Paramagnetism of rare earth and iron group ions, Crystal field Splitting and quenching of orbital, Angular momentum. Paramagnetism of conduction electrons. Ferromagnetism , Ferrimagnetism and Antiferromagnetism: Curie point and exchange integral, saturation magnetization. Magnons: Magnon dispersion relation for ferromagnetic lattices. **Superconductivity:** Superconductivity, critical temperature, Meissner effect, Destruction of superconductivity by magnetic field, Type I and type II superconductors, Isotope effect, energy gap, London equation, London penetration depth, Coherence length, BCS theory of superconductivity.	12

PRACTICALS	
1.	To study the dielectric behavior of PZT ceramic by determining dielectric strength, dielectric constant and dielectric glasses.
2.	To Determine the resistivity of a graphite sample using four probe method. Curie Temperature of a ferromagnetic material
3.	To draw the BH loop of ferrite material and determine the remanance and coercive fields. Study the clipper and clamper circuits.

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4.	DSC/DTA/TGA studies for thermal analysis of materials

MSPH18106- Relativity & PLASMA PHYSICS

L	T	P	Cr
3	1	0	4

RATIONALE
This course deals with Electrodynamics and Plasma Physics.

UNITS	CONTENTS	Contact Hrs.
I	**Boundary Value Problems:** Uniqueness Theorem, Dirichlet or Neumann Boundary conditions, Green's Theorem, Formal solution of Electrostatic &Magnetostatic Boundary value problem, Method of images with examples	8
II	**Time Varying Fields and Maxwell Equations:** Faraday's Law of induction, Displacement current, Maxwell equations, scalar and vector potentials, Gauge transformation, Lorentz and Coulomb gauges, Hertz potential, General Expression for the electromagnetic fields energy, Conservation of energy, Poynting's Theorem, Conservation of momentum	10
III	**Electromagnetic Waves:** Wave equation, Plane waves in free space and isotropic dielectrics, Polarization, Energy transmitted by a plane wave, Waves in conducting media, Skin depth. Reflection and Refraction of electromagnetic waves at plane interface, Fresnel's amplitude relations. Reflection and transmission coefficients, Polarization by reflection. Brewster's angle, Total internal reflection, EM wave guides, TE, TM and TEM waves, Rectangular wave guides. Energy flow and attenuation in wave guides, Cavity resonators	10
IV	**Radiation from Localised Time Varying Sources:** Solution of the inhomogeneous wave equation in the absence of boundaries. Fields and Radiation of a localized oscillating source, Electric dipole and electric quadruple fields, Centre fed linear antenna. **Charged Particle Dynamics:** Non-relativistic motion in uniform constant fields and in a slowly varying magnetic field. Adiabatic invariance of flux through an orbit, magnetic mirroring, Relativistic motion of a charged particle.	12

REFERENCE BOOKS :

1.	Electromagnetic Wave and radiating systems	Jordan E. C. and Balmain K. G
2.	Introduction to Electrodynamics	Griffiths D.J.,
3.	Classical Electrodynamics	Jackson J.D
4.	Classical Electrodynamics	Puri S.P

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M.Sc 2ND YEAR

MSPH18201- NUCLEAR PHYSICS

L	T	P	Cr
3	1	0	4

RATIONALE
This syllabus covers nuclear size and shape, kind of interaction and different models.

UNITS	CONTENTS	Contact Hrs.
I	**Nuclear Size and Shape:** Scattering and electromagnetic methods for determining the nuclear radius, Wave mechanical properties of nucleus and statistics, Electric and magnetic moments and nuclear shapes.	10
II	**Nuclear Forces:** Types of nuclear potentials, Ground and excited states of deuteron, Exchange forces and mass formula, n-p scattering at low energies, Scattering length, Spin dependence of n-p scattering, effective range theory in n-p scattering, p-p scattering at low energy, Phenomenological two nucleon potential.	10
III	**Nuclear Shell Model:** Coupling of angular momenta, C.G. Coefficients and Racah coefficients, extreme single particle model and analysis of its predictions, Spin-orbit coupling, Single particle model, Magnetic moment, Electric quadrupole moment	8
IV	**Collective Model of Nucleus:** Collective motion, parametrization of nuclear surface Rotation of deformed nuclei, Collective model Hamiltonian, nuclear wave function for even-even nuclei and odd-A nuclei, Rotation-vibrational coupling, Nilsson model, Cranking shell model. **Nuclear Reactions:** Type of reactions, reaction cross section, conservation laws, Q-values and its significance, Coulomb excitation, Breit-Wigner formula, compound nucleus, energy of excitation, Direct reactions.	12

REFERENCE BOOKS :		
1.	Nuclear Physics	Roy R.R. & Nigam B.P
2.	Structure of Nucleus	Preston M. A. and Bhaduri R. K
3.	Theory of Nuclear Structure	Pal, M.K
4.	Nuclear Physics	Tayal D. C

MSPH18202- STATISTICAL Mechanics

L	T	P	Cr
3	1	0	4

RATIONALE
Statistical Mechanics is the mechanics of data and theory. The course covers all the aspects of Statistical Mechanics.

UNITS	CONTENTS	Contact Hrs.
I	**The Statistical Basis of Thermodynamics:** The macroscopic and microscopic states, contact between statistics and thermodynamics, classical ideal gas, Gibbs paradox and its solution. **Ensemble Theory:** Phase space and Liouville's Theorem, The microcanonical ensemble theory and its application to ideal gas of monatomic particles, Partition function, Classical ideal gas in canonical ensemble theory, Energy fluctuations, Equipartition and virial theorems, A system of harmonic oscillators as canonical ensemble.	12
II	**Ideal Fermi Systems:** Thermodynamic behavior of an ideal Fermi gas, Discussion of heat capacity of a free-electron gas at low temperatures, Pauli paramagnetism, Statistical equilibrium of white dwarf stars.	8
III	**Ideal Bose Systems:** Basic concepts and thermodynamic behavior of an ideal Bose gas, Bose-Einstein condensation, Discussion of gas of photons (the radiation fields) and phonons (The Debye field), Liquid helium and super fluidity	10
IV	**Elements of Quantum Statistics:** Quantum states and phase space, The density matrix, Canonical density matrices for a particle in a box and a linear oscillator, Quantum statistics of various ensembles. An ideal gas in quantum mechanical ensembles	10

REFERENCE BOOKS :

1.	Statistical Mechanics	Pathria R.K.,
2.	Fundamentals of Statistical and Thermal Physics	Reif F.
3.	Statistical Mechanics	Gambhir and Lokanathan
4.	Statistical Mechanics	KersonHaung

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MSPH-18203 ComputationalPhysicsAnd MICROPROSSESER

Fortran 90 Programming: Operating systems, Flow charts, Integer and Floating point arithmetic, built-in functions, Executable and non-executable statements, Assignment, Control and input/output commands, Subroutines and functions, Operation with files, Debugging and testing.

Numerical Algebraic and Transcendental Equations: Methods for determination of zeroes of linear and nonlinear algebraic and transcendental equations, Convergence of solutions, Solution of simultaneous linear equations, Evaluation of numerical determinants, Gaussian elimination and pivoting, Matrix inversion, Iterative methods.

Interpolation and Approximation: Introduction to interpolation, Lagrange approximation, Newton polynomials, Curve fitting by least squares, Polynomial least squares and cubic splines fitting.

Numerical Differentiation and Integration: Numerical differentiation, Quadrature, Simpson's rule, Gauss's quadrature formula, Newton – Cotes formula.

Random Variables and Monte Carlo Methods: Random numbers, Pseudo-random numbers, random number generators, Monte Carlo integration: Area of circle, Moment of inertia, Monte Carlo Simulations: Buffen's needle experiment, Random walk, Importance sampling.

Differential Equations: Euler's method, RungeKutta methods, Predictor-corrector methods, Finite difference method, Finite difference equations for partial differential equations and their solution.

Laboratory Assignments: To find mean, standard deviation and frequency distribution of an actual data set from any physics experiment, Wein's constant using bisection method and false position method.To solve Kepler equation by Newton-Raphson method, Van der Wall gas equation for volume of a real gas by the method of successive approximation. Interpolate a real data set from an experiment using the Lagrange's method differences and cubic splines. Fit the Einstein's photoelectric equation to a realistic data set and hence calculate Plank's constant. Estimate the value of π by rectangular method, Simpson rule and Gauss quadrature by numerically evaluating any suitable integral.cFind the area of a unit circle by Monte Carlo integration.cTo simulate Buffen's needle experiment.

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MSPH 18204-Solid State Physics-I

Unit I: Crystallography: External symmetry elements of crystals, crystal systems, Bravais lattices, Concept of point group, stereograms for 32 point groups, Space groups, derivation of equivalent point positions (with examples from triclinic systems), Miller andBravais indices, unit cell, Wigner-Seitz unit cell, Reciprocal lattice, Principle of powder diffraction method, Elementary ideas about Interpretation of Powder photographs, Analytical indexing

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Unit II : Band Theory: Bloch theorem, the Kronig- Penney model, construction of Brillouin zones, extended and reduced zone schemes, effective mass of an electron, tight binding approximation,
Empty lattice approximation, Band structure for f.c.c. and b.c.c. metals, Fermi surface, effect of electrical field and magnetic fields on Fermi surface. Basic Principles and outline of Experimental methods for studying Fermi surface.

Unit III: Lattice Dynamics: Energy of atomic motions, adiabatic principle, harmonic approximation, cyclic boundary condition. Lattice vibrations of linear monoatomic and diatomic chains. Dispersion relations, acoustic and optical phonons.
Theories of lattice specific heat, Dulong and Petit‟slaw, Einstein and Debye models, T3 law, Born procedure, anharmonicity and thermal expansion.

Text and Reference books:

1 Solid State Physics, A.J. Dekker, Macmillan India Ltd. (2005)
2. Solid State Physics, Charles Kittel, John Willey & Sons
3 .Physics of Semiconductor Devices – Physics and Technology: M.S. Sze,John Willey & Sons
4. Introduction to Solids – Azaroff
5. Solid State Physics- A.J. Blackmore
6. Fermi Surface Cracknell and Wang
7. Lattice Dynamics- Ghatak and Loknathan
8. Solid State Physics Kubo and Nagamiya

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MSPH-18205 Solid State-II

Free electron theory: Fermi gas, specific heat, Ohm's law, magneto-resistance, thermal conductivity Weidman-Franz law;
Band theory: Bloch theorem, nearly free electron model, classification of metal, insulator and semiconductor, motion of electron in energy bands, effective mass, tight binding model, Fermi surfaces of metals, de Hass-van Alphen effect;
Semiconductor: Intrinsic and extrinsic semiconductors, mobility and electrical conductivity, Fermi level, Hall effect, cyclotron resonance;
Magnetism: Diamagnetism, Hund's rules, Lande g-factor, quantum theory of paramagnetism, Pauli paramagnetism, exchange interaction, ferromagnetism, Ising model, Heisenberg model, mean field theory, magnons and spin waves, ferromagnetic domains, magnetic anisotropy energy, hysteresis; **Superconductivity**: Meissner effect, London equations, type-I and type-II superconductors; Ginzburg-Landau theory, outlines of BCS theory, flux quantization.

Text:

1. **Introduction to Solid State Physics, C. Kittel, 8th ed; John Wiley & Sons(2005).**
   Solid State Physics, J.D. Pattersonand B.C. Bailey; Springer(2007

References:

   Solid State Physics, N. W. Ashcroft and N. D. Mermin; Harcourt Asia Pte.Ltd.(2001).
2. Solid State Physics, M. S. Rogalski and S. B. Palmer; Gordon and Breach SciencePublishers (2001).

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