MASTER OF SCIENCE IN PHYSICS (MSc PHYSICS)
DURATION:2 YEARS

1 Year							
Subject Code	**Subject Title**	**IA Max. Marks**	**University Examinations**		**Total Marks**	**Min. Pass**	**Credits**
			Max. Marks	**Min. Pass**			
MC401	LIFE SKILLS	20	80	**35**	100	**35**	4
MPH402	MATHEMATICAL PHYSICS	20	80	**35**	100	**35**	4
MPH403	CLASSICAL AND STATISTICAL MECHANICS	20	80	**35**	100	**35**	4
MPH404	ELECTRONICS	20	80	**35**	100	**35**	4
MPH405	CONDENSED MATTER PHYSICS	20	80	**35**	100	**35**	4
MPH406	PRACTICAL I GENERAL EXPERIMENTS	20	80	**35**	100	**35**	4
						Total Credits	**24**

2 Year							
Subject Code	**Subject Title**	**IA Max. Marks**	**University Examinations**		**Total Marks**	**Min. Pass**	**Credits**
			Max. Marks	**Min. Pass**			
MC501	LIFE SKILLS	20	80	**35**	100	**35**	4
MPH502	ELECTRO MAGNETIC THEORY	20	80	**35**	100	**35**	4
MPH503	QUANTUM MECHANICS	20	80	**35**	100	**35**	4
MPH504	SPECTROSCOPY	20	80	**35**	100	**35**	4
MPH505	PRACTICAL II ELECTRONICS EXPERIMENTS	20	80	**35**	100	**35**	4
MPH506	PROJECT 75 AND VIVA 25	20	80	**35**	100	**35**	4
						Total Credits	**24**

MATHEMATICAL PHYSICS

UNIT-I Vector space and Tensors

Vector Space-Definitions-Linear independence of Vector-Bilinear and quadratic forms-change of basis-Schmidt's orthogonalisation processes-Swartz inequality-Application of vectors to hydrodynamics the equation of flow in solids.

Tensors-N-dimensional space–superscripts-subscripts-coordinate transformations kronecker delta symbol-properties of kronecker generalized kronecker delta Tensors of higher ranks-Algebric operation of Tensors-symmetric and asymmetric Tensors-Application of Tensors-Dynamics of a particle-Elasticity-Rigid bodies

UNIT-II Fourier's and Laplace's integral transforms.

Fourier transform – properties of Fourier's transform-Fourier transform of a derivative- Fourier's Sine and cosine transform of a derivative-Finite Fourier transforms-Simple application of Fourier transforms-Laplace transforms- properties of Laplace transform-Laplace transforms of a derivative of a function- Laplace transforms of integral-Inverse Laplace transform- Properties of inverse Laplace transform –convolution theorem-Application of Laplace transform.

UNIT-III Complex variable

Function of complex variables-limit-continuity-Differentiability-Analytic function-Cauchy-Rieman condition-Differential equation-Cauchy Integral theorem – Cauchy Integral formula- Moreva's theorem – Liouville's theorem – Taylors series – Laurent's series – singularities of an analytical function – Residues-Cauchy Residue theorem – Evaluation of definite integrals – contour integration.

UNIT – IV Special function and differential equations

Gamma and Beta functions-Liouville problem-solution for Bessel-Legendre-Lagure and Hermite differential equation-properties-Generating functions-Rodrigue's formula-orthogonal properties-recurrence relation

UNIT-V Dirac delta function and green's function

Direct-Delta function-Three dimensional delta function-Green's function – for one dimensional case-Symmetry properties of green function-Green's function for poisson equation-Quantum mechanical scattering problem.

CLASSICAL AND STATISTICAL MECHANICS

A.CLASSICAL MECHANICS

UNIT – I

Elementary Principles – D'Alembert's principle – Lagrange's equation – Hamilton's equation – Lagrangian and Hamiltonian

Two body central Force Problem

Equations of motion and first integrals – Kepler's laws – scattering by a central potential – transformation from center of mass to laboratory frame.

Special relativity in classical mechanics

Relativistic Lagrangian and Hamiltonian for a particle – space, time and energy – momentum – four vectors – center of mass system for relativistic particles – invariance of Maxwell's equations.

UNIT II

Kinematics of Rotation

Orthogonal transformations – Euler poles – Rotating frames of reference and coriolis force

Mechanics of Rigid bodies

Angular momentum and kinetic energy – moment of inertia tensor – Euler's equations of motion – Torque free motion – Motion of a symmetric top under gravity.

UNIT III

Canonical Transformations

Canonical transformations and their generators – simple examples – poisson brackets

Hamilton Jacobi Theory

Hamilton – Jacobi equations – Action angle variables – Application to kepler problem

Small oscillations

Formulation of the problem – Transformation to normal coordinate – Linear triatomic molecule

B. STATISTICAL MECHANICS

UNIT IV

Classical Statistical Mechanics:

Postulates – Liouville's theorem – Micro canonical, canonical and grand canonical – examples – Partition function and entropy of ideal gas – Gibb's paradox.

Quantum Statistical Mechanics

Liouville's equation – Postulates of quantum statistical mechanics – Bose-Einstein, Fermi-Dirac distributions

UNIT V

Ideal Bose gas:

Equation of state – Bose-Einstein condensation – Landau's theory of liquid Helium II – Black body radiation – Phonons

Ideal Fermi gas

Equation of state – free electron gas in metals – heat capacity – Pauli's Para magnetism – Thermionic emission.

ELECTRONICS

UNIT – I

Operational amplifier and analog computation

Operational amplifiers –characteristics and parameters– Mathematical operations – logarithmic – antilog amplifiers – Analog multiplier and

divider – solutions to simultaneous equations –differential equations, harmonic oscillator, damped harmonic oscillator, rocket launching.

UNIT – II

Wave form generators and Active filters

Sine wave oscillation with phase shift and wein's networks-Comparator-Schmitt Trigger-Astable and Monostable operations-Triangular wave generator.

Active filters-Butterworth filters design-Second order law-Low,High and Band pass filters-Band notch filter.

UNIT – III

Data Converters

Digital to analog Converters - Binary weighted – Resistor, DAC – R/2R ladder DAC – Successive approximation method –Single slope and Dual slope ADC-– counter type-Resolution, Accuracy and Linearity.

UNIT –IV

Memories and Measuring Instruments

Static shift register memory – Dynamic MOS shift register memory – CMOS shift register memory – Charge Coupled Device (CCD) – Practical CCD Memory – Content Addressable Memory (CAM) –Magnetic recording technique – magnetic tape – magnetic bubble memory – magnetic disk storage – floppy disk – Winchester disk – compact disk (CD) – digital audio CD – laser CD.

Q meter – Dual trace oscilloscope – sampling oscilloscope – analog recorders – XY recorders – Digital recorders – Digital displays – wave

analyzers and spectrum analyzer – Digital voltmeter and multimeters – Electronic counters.

UNIT V:

Architecture of Microcontroller 8051

Introduction – comparison between microcontroller and microprocessors – architecture of 8051 – key features of 8051 – Memory organization – data memory and program memory – internal RAM organization – special function registers – control registers – I/O ports – counters and timers – interrupt structure.

Programming the Microcontroller 8051

Instructions set of 8051 – arithmetic, logical, data move, jump and call instructions - addressing modes – immediate, register, direct and indirect addressing modes – assembly language programming – simple programs to illustrate arithmetic and logical operations (sum of numbers, biggest and smallest in an array) – software time delay.

CONDENSED MATTER PHYSICS

UNIT – I

Lattice Dynamics:

Monoatomic lattices – Brillouin zones – group and phase velocity – lattice with 2 atoms per primitive cell – quantization of lattice vibrations – phonon

momentum – lattice heat capacity – Einstein's model and Debye's model of specific heat Thermal expansion and thermal conductivity – Unclapp processes.

Imperfections in Crystals

Point defects – lattices vacancies and interstitial atoms (Schottkey defect) – Frenkel defect – colour centers-F Centre – line defects – edge dislocation – screw dislocations – dislocations motion – strain due to dislocation motion – strain fields around dislocation – plane defects – grain boundaries dislocation.

UNIT – II

Transport phenomena and Band theory

Drude theory of metals – Hall effect – Fermi electron gas in 3D – Heat capacity – Non equilibrium distribution function – Boltzmann transport equation – electrical and thermal conduction – Wiedemann – Franz law – de Hass Van Alphen effect – oscillatory phenomenon and Landau levels.

Bloch's theorem – Kronig penny model – Brillouin zones – crystal momentum of an electron – wave function near zone boundary – Fermi surface – density states – electrical resistivity – band gap – equation of motion for an electron in an energy band – holes – effective mass – intrinsic and extrinsics carrier concentration – impurity conduction.

UNIT – III

Semiconductor Physics

Concept and importance of Fermi surface-Construction of two dimensional fermi surface-Crystal momentum and origin of effective mass-Experimental methods of Fermi surface studies-Quantization of orbits in a magnetic field.

Expression for position of Fermi levels and carrier concentrations-Variation of Fermi level with temperature- Carrier mobility, Conductivity and their variation with temperature-Direct and Indirect band gap semiconductors-Differences and examples-Hall effect continuity equation-Drift and Diffusion-Einstein relation-Generation, Recombination and life of non-equilibrium carriers-Heyness-Schockley experiment.

UNIT – IV

Ferro magnetism and Superconductivity:

Classification and properties of ferroelectrics – Spontaneous polarization –Ferroelectric domains – Thermo dynamics of Ferro Electric Transition –

Classification – Weiss field theory – Temperature dependence of spontaneous magnetization – Heisenberg model – Exchange interaction – Exchange integral – Ferromagnetic domains – Magnetic bubbles – Bloch wall – Thickness and energy – Ferromagnetic spin waves – Quantization – Magnons – Dispersion relations – Ferrites – Structure.

Super Conductivity:

Thermodynamics of super conducting transitions – the London equations and penetration depth – Cooper pair – BCS theory – energy gap – Flux quantization – persistent currents – Ginsberg – Landau theory – Josephson tunneling – Josephson effects – SQUIDS.

UNIT – V

Crystal growth and Nano crystalline solids

Nucleation and growth – Homogeneous and heterogeneous nucleation – Classification of crystals growth techniques – Melt growth techniques – Bridgemann, Czechrolski, Liquid encapsulation Czochralski and Zone melting techniques – Necessity of characterization – Chemical analysis.

Definitions-Nano-Crystalline and non-crystalline Materials-General Methods of preparation of Nano structured metals, Alloys and semiconductors by Physical and chemical routes-Inert Gas condensation technique and Sol-Zel process- Quantum Wells, wires and Dots-density of states.

PRACTICAL – I GENERAL EXPERIMENTS

(Any Ten experiments to be done)

1. Young's modules – Elliptical and Hyperbolic fringes
2. Stefan's constant
3. Coefficient of Linear expansion – Airwedge method.

4. B – H Loop using Anchor Ring
5. Susceptibility – Guoy and Quincke's methods
6. Hydrogen spectrum – Rydberg's constant
7. Solar spectrum – Rydberg's constant
8. F.P. Etalon
9. L.G Plate
10. Michelson's Interferometer
11. Arc Spectra Fe-Hg (or) Cu-Hg (or) Brass-Hg
12. Molecular spectra ALO band or CN band
13. Viscosity of liquid – Meyer's Disc
14. Solar constant
15. Ultrasonic interferometer - compressibility
16. Temperature coefficient of thermister
17. Semiconductor – Band gap energy
18. Hall effect - semiconductor
19. GM Counter
20. Laser experiments:
    i) Diffraction at straight edge
    ii) Interference – Lloyda single mirror method
    iii) Interference using optically plane glass plate and laser
    iv) Diffraction at a circular aperture
21. Experiments on optical fiber
22. Microwave test bench – Dielectric measurements of liquid / solid

ELECTROMAGNETIC THEORY

UNIT-I

ELECTROSTATICS

Gauss Law –Poisson & Laplace equations- Solution of Laplace equation in spherical polar coordinate- conducting sphere-multipole expansion-Electrostatic energy-Dielectrics-Polarization and Displacement vectors-Boundary conditions-Dielectric sphere in a uniform field- Molecular polarisability and electric susceptibility-Electrostatic energy in dielectric medium- Clausius- Mossotti equation.

UNIT-II

MAGNETOSTATICS

Biot- Savart's law-divergence and curl of magnetic induction-magnetic vector potential-Ampere's circuital law-magnetic field of a localized current distribution-magnetic moment and force on a current distribution in an external field- magneto static energy-magnetic induction and magnetic field in macroscopic media-boundary conditions- uniformly magnetized sphere.

UNIT-III

ELECTROMAGNETICS

Faraday's law of induction-Maxwell's equation-Maxwell's displacement current-vector and scalar potential-Gauge transformation-Lorentz gauge-Coulomb gauge-Conservation laws for a system of changes-Poynting theorem.

UNIT-IV

WAVE PROPAGATION

Propagation of e.m wave in free space-non conducting medium-conducting medium-skin depth-reflection and transmission at dielectric boundaries-polarization-Guided waves-Wave guides-Propagation of waves

in a rectangular wave guide-inhomogeneous wave equation and retarded potentials-field and radiation due to an oscillating electric dipole.

UNIT-V

PLASMA PHYSICS

Plasma-Debye length-plasma oscillations-plasma behavior in a magnetic field-Boltzmann equation- magneto hydrodynamic equations-electron plasma oscillations-Debye shielding problem- plasma confinement in a magnetic field- pinch effect- magneto hydrodynamic waves- Alfven waves

QUANTUM MECHANICS

Unit-1

Wave mechanical Concepts and formalism of quantum mechanics

Wave nature of particles – uncertainty principle-superposition-wave packet- time dependent Schrodinger equation- physical interpretation of wave function-Ehrenfest's theorem-time independent Schrodinger equation-admissibility conditions on the wave function. Postulates of quantum mechanics-simultaneous measurability of observables-Dirac notation momentum represtation.

Energy Eigen value problems: Square well potential –rigid and Finite walls - Potential barrier-α-paricle emission –Harmonic oscillator: Schrodinger and operator method. Three dimensional energy eigenvalue problems: particle in spherically symmetric potential- Hydrogen atom-hydrogenic orbital-square well potential-the Deutron.

Unit-2

Matrix formulation of quantum theory, identical particles and angular momentum

State vectors and functions-Hilbert space-Matrix theory of Harmonic oscillators-Schrodinger, Heissenberg and interaction pictures- coordinate and momentum representation-symmetry and conservation laws. Identical particles: symmetry and antisymmetric wave functions -spin and statistics - Pauli's exclusion principle-slater determinant-collision of identical particles.

Angular momentum operators-commutation relations-Eigen values and Eigen functions of L_2 and L_z –Eigen functions of J^2 and J_z – addition of angular momenta-Clebsch Gordan coefficients.

Unit -3

Time- independent perturbation theory and Approximation methods

Basic concepts-Nondegenerate energy levels-Anharmonic oscillator: First order correction-ground state of Helium- stark effect- Spin orbit interaction Zeeman effect.

Variation method: variational principle – excited states-Hellmann Feynman theorem-ground state of Helium- ground state of Deutron. WKB method- Connection formulas-validity of WKB method-barrier penetration.

Unit-4

Time – independent perturbation theory and Scattering

Time –independent perturbation theory : First order perturbation-Harmonic perturbation-transitions-Einsteins A & B coefficients - selection rules.

Scattering: scattering cross-section-scattering amplitude-partial waves-scattering by a central potential: Partial wave analysis-scattering by attractive square well potential-scattering length-phase shifts-Born approximation and its validity-Laboratory and centre of mass coordinate system.

Unit-5

Relativistic wave equations

Klein-Gordon equation and interpretation- Particle in a coulomb field-Dirac's equation for free particle-Dirac matrices and its covariant form–Probability density-Plane wave solution-negative energy states-spin of the Dirac Particle –magnetic moment of the electron-spin orbit interaction - central potential-Hydrogen atom-lamb shift.

SPECTROSCOPY AND NUCLERAR PHYSICS

A.Spectroscopy

UNIT-I

Vibrational Spectroscopy

Symmetry of polyatomic molecules and molecular vibrations-Group theory and Selection Rules for Raman and IR vibrational normal modes-Calculation of normal modes for Raman and IR activity to C2v and C3v point groups – Representations for molecular vibrations-Internal and symmetry coordinates-Calculation of F-G matrix-Normal coordinate analysis for XY_2 bent symmetrical type molecule.

IR- SPECTROSCOPY

Principle and theory of Infrared spectroscopy-Far IR and Near IR absorption spectroscopy-Mid IR. FT-IR spectroscopy-Vibrational frequencies and qualitative analysis – sampling methods – Instrumentation - Applications

RAMAN SPECTROSCOPY

FT Raman spectroscopy – degree of depolarization – structure determination using IR and Raman spectroscopy – Resonance Raman spectroscopy – Coherent anti – Stokes Raman spectroscopy .

UNIT-II

NMR and ESR Spectroscopy

Basic principles of interaction of spin and applied magnetic field – concept of NMR spectroscopy – high resolution continuous wave NMR spectrometer – advantage of FT-NMR – Chemical shift – simple application to structural determination – first order and second order spectrum – double resonance and spin tickling

Origin of electron spin resonance – design of ESR spectrometer – hyper fine structure study – ESR study of anisotropic systems – Triplet states study of ESR – application of ESR to crystal defects and biological studies

UNIT-III

NQR and Mossbauer spectroscopy

Principles of NQR – Energy levels of quadrupole transistions for half integral spins – design of NQR spectrometer – application of NQR to chemical bonding and molecular structures

Principle of Mossbauer effect – schematic arrangements of Mossbauer spectrometer – isomer shift – quadrupole interaction – magnetic hyperfine interactions-applications to molecular and electronic structures.

B.Nuclear Physics

UNIT IV

Nuclear Reactions and Scattering Process:

Bohr Wheeler's theory of nuclear fission – Fission reactors –power and breeder type reactor – Nuclear fusion – Basic fusion process – Solar fusion – cold fusion – controlled thermonuclear reactions Energetics of reactions – Q equation – level widths in nuclear reaction – Nuclear reaction cross section .

The scattering cross section – scattering amplitude – Expression in terms of Green's function – Born approximation and its validity – Screened coulomb potential – Alpha particles scattering – Rutherford formula.

UNIT V

Elementary Particles: Four types of interactions and classifications of elementary particles – isospin – isospin quantum numbers – Strangeness and Hyper charge – Hadrons Baryons – Leptons – Invariance principles and symmetries – Invariance under charge – parity (CP), Time (T), and CPT – CPT violation in neutral K meson decay – Quark model SU (3) symmetry – Gellmann – Nishijama formula – Gauge theory of weak and strong interactions – charm, bottom and top quarks.

Practical II

Advanced Electronics and Micro controller Experiments

Advanced Electronics Experiments (Any five experiments to be done)

1. FET characteristics and Design of FET amplifier
2. UJT characteristics and Design of Saw tooth wave oscillator
3. Design of square wave generator using IC 741 and Timer 555 ICs – 555 IC as VCO.
4. Design of Monostable multivibrator using the IC s 741 and 555 timer- study of frequency divider.
5. Design of schmidt's Trigger using the ICs 741 and 555 timer – squarer
6. Analog computer circuit design – solving the simultaneous equations.
7. Design of second order Butterworth active filter circuits – Low pass, High pass and Multiple feed back band pass filters
8. Binary addition and subtraction – 7483 IC
9. Counters and shift registers – 7476/7473 IC
10. BCD counter – Decoding and Display
11. Design of binary weighted and R/2R Ladder DAC using the IC 741
12. Construction of ADC using DAC, comparator and counter

Micro Controller Experiments (Any five experiments):

1. Interfacing of ADC 0809
2. Interfacing of LED – study of counters
3. Interfacing of seven segment display – Display of Alphanumeric character

4. Stepper motor interfacing
5. Traffic light controller
6. Hex – key board interface
7. Programmable counter / Interval Timer – 8253 Experiments.
8. Temperature Controller

9. Microcontroller based experiments

i) Arithmetic operations

ii) Array operations

iii) Code conversion

(Option 18 compulsory)