M.Sc. Physics
(Syllabus: Semester I & II)

Semester-I

1. **Subject Code: MSPH 101** **Course Title: Mathematical Physics**
2. Contact Hours: L: 3 T: 1 P: 0
3. Examination Duration (Hrs): Theory: 3 Practical: 0
4. Relative Weight: CWS: 25 PRS: 0 MTE: 25 ETE:100 PRE: 0
5. Credits: 4
6. Semester: ODD
7. Subject area: DCC
8. Pre-requisite: NIL
9. Objective: The main objective of this course is to familiarize students with a range of mathematical methods that are essential for solving advanced problems in quantum mechanics, electrodynamics and other fields of theoretical physics.
10. Detail of Course:

S. No.	Contents	Contact Hours
1.	**Complex analysis & Vector Analysis:** Real and complex numbers; Euclidean space; Function of a complex variable; Analytic functions; Cauchy's theorem; calculus of residues and applications. Advanced vector calculus; multiple integrals, Introduction to tensors.	**12**
2.	**Linear Vector Space:** A brief review of linear vector spaces, Inner product, norm, Schwarz inequality, linear operators, eigenvalue and eigenvector, adjoint of a linear operator, Hermitian or self-adjoint operators and their properties, unitary operators, orthonormal basis –discrete and continuous.	**8**
3.	**Linear Differential Equations & Special Functions:** Series solutions of ordinary differential equations; ordinary, regular and irregular singular points; Gamma function; Special functions (Legendre, Bessel, Laguerre, Hermite); **Partial Differential Equations:** Classification of PDE's and boundary conditions; method of separation of variables; A brief review of Fourier and Laplace transforms, Dirac delta functions;	**14**
4.	**Elements of Group Theory:** Definitions and examples of a group; subgroup, cosets, conjugate classes, invariant subgroups and factor group; isomorphism and homomorphism; Permutation groups; Representations of a group, Reducible and irreducible representations, orthogonality relations; Topological groups and Lie groups, SO(2), SO(3), Lorentz group, Generators of U(n) and SU(n), SU(2), SU(3).	**8**
	Total	**42**

<u>Suggested Books</u>

S. No.	*Name of Books/ Authors*	**Year of publication/ Reprint**
1.	*Mathematical Physics* by V.Balakrishnan	Ane Books Pvt. Ltd.
2.	*Mathematical Methods for Physicists* by Arfken	
3.	*Advanced Engineering Mathematics* by Kreyzig	8th Edition, Wiley India (P.) Ltd.
4.	*Group Theory and its Applications to Physical Problems* by M Hammermash	Dover Publications; Reprint edition (December 1, 1989)
5.	*Vector Analysis and an introduction to Tensor Analysis* by Murray R Spiegel	McGraw-Hill; 1 edition (June 1, 1968)
6.	*Linear Algebra* by Seymour Lipschutz & Marc Lars Lipson	McGraw-Hill Education; 5 edition (16 December 2012)
7.	*Complex Variables with an introduction to Conformal Mapping and its Applications* by Murray R Spiegel, Seymour Lipschutz, John J. Schiller, Dennis Spellman	McGraw-Hill Education; 2 edition (17 May 2009)

1. **Subject Code: MSPH 103** **Course Title: Classical Mechanics**
2. Contact Hours: L: 3 T: 1 P: 0
3. Examination Duration (Hrs): Theory: 3 Practical: 0
4. Relative Weight: CWS: 25 PRS: 0 MTE: 25 ETE:100 PRE: 0
5. Credits: 4
6. Semester: ODD
7. Subject area: DCC
8. Pre-requisite: NIL
9. Objective: To develop familiarity with the physical concepts and facility with the mathematical methods of classical mechanics. To represent the equations of motion for complicated mechanical systems using the Lagrangian and Hamilton formulation of classical mechanics.

10. Detail of Course:

S. No.	Contents	Contact Hours
1.	**Basic Principles of Classical Dynamics:** Newton's laws and symmetries. Generalized coordinates and types of constraints on dynamical systems, D'Alembert principle and Euler-Lagrange equation of motion, Variational calculus, Lagrangian and Hamiltonian formalisms and equations of motion for central forces, electromagnetic forces, coupled oscillators and other simple systems; Poisson brackets and canonical variables; Jacobi Identity.	**12**
2.	**Transformations:** Canonical Transformations, generator of infinitesimal canonical transformations, Symmetry, invariance and conservation laws, cyclic coordinates; Phase space trajectories, Liouville's theorem, Hamilton-Jacobi theory, Action-angle variables.	**10**
3.	**Center of mass and Laboratory problems and Small Oscillations:** Kepler problem. Perturbation and precessing orbits. The classical scattering problem. Small oscillations (non-diagonal kinetic and potential terms).Small Oscillations, normal coordinates, and its application to chain molecules and other problems, Degrees of freedom for a Rigid Body, Euler angles, Rotating Frame, Coriolis force, Foucault's pendulum, Eulerian Coordinates and equation of motion for a rigid body, motion of the symmetrical top.	**12**
4.	**Special relativity**: Internal frames. Principle and postulate of relativity. Lorentz transformations. Length contraction, time dilation and the Doppler effect. Velocity addition formula. Four- vector notation. Energy-momentum four-vector for a particle. Relativistic invariance of physical laws.	**8**
	Total	**42**

<u>Suggested Books</u>

S. No.	Name of Books/ Authors
1.	*Mechanics by Landau and Lifshitz*
2.	*Classical Mechanics by Goldstein*
3.	*Classical Mechanics by Rana and Jaog*
4.	*Classical Mechanics by J. W. Muller- Kirsten*
5.	*Classical Mechanics of particles and Rigid Bodies by K.C. Gupta*

1. **Subject Code: MSPH 105** — **Course Title: Quantum Mechanics**
2. Contact Hours: L: 3 T: 1 P: 0
3. Examination Duration (Hrs): Theory: 3 Practical: 0
4. Relative Weight: CWS: 25 PRS: 0 MTE: 25 ETE:100 PRE: 0
5. Credits: 4
6. Semester: Odd
7. Subject area: DCC
8. Pre-requisite: NIL
9. Objective: This course aims at providing an elementary introduction to the basic principles of (non-relativistic) Quantum Mechanics, its wave-mechanical and matrix-mechanics formulations, and its applications to simple problems.

10. Detail of Course:

S. No.	**Contents**	**Contact Hours**
1.	**Introduction:** Problems with classical physics: double-slit experiment: quantum mechanical wave function and Born interpretation, A brief review of problems involving Schrodinger equation in one dimension (box potential, potential barrier and tunneling, potential well), Hydrogen atom: Schrodinger equation for a particle moving in a central force field, energy levels and eigenvalues, bound states.	**08**
2.	**Linear Vector and Representation Theory**: Linear vector space, Dirac notations of Bra - Ket notation, Matrix representation of Observables and states, Determination of eigenvalues and eigenstate for observables using matrix representations, Change of representation and unitary transformations, Coordinate and momentum representations, Equations of motion in Schrödinger and Heisenberg pictures.	**10**
3.	**Theory of Angular Momentum and Many-particle Physics:** Quantum theory of angular momentum: Raising and lowering operators, eigenvalues and eigenfunctions, Spin angular momentum, Symmetry, invariance and conservation laws, relation between rotation and angular momentum, commutation rules, Matrix representations, addition of angular momenta and Clebsch-Gordon coefficients, Pauli spin matrices. Many-particle Schrodinger wave equation; Identical particles: Physical meaning of identity, Principle of indistinguishability and its consequences, Exchange operator, Symmetric and anti-symmetric wave functions, Connection between spin, symmetry and statistics, Pauli exclusion principle and Slater determinant; Application to the electronic system of the helium atom (para- and ortho helium).	**14**
4.	**Approximation Methods:** Time-independent Perturbation theory (non-degenerate and degenerate) and applications to fine structure splitting, Zeeman effect (Normal and anomalous), Stark effect, and other simple cases, Variational method and applications to helium atom and simple cases; WKB approximation and applications to simple cases. Time dependent Perturbation theory, Fermi's Golden rule, Semi-classical theory of interaction of atoms with radiation.	**10**
	Total	**42**

Suggested Books

S. No.	**Name of Books/ Authors**	**Year of publication/ Reprint**
1.	*Quantum Mechanics by L. I. Schiff*	McGraw-Hill; 3 Rev Ed edition (1968)
2.	*Modern Quantum Mechanics by J. J. Sakurai*	Pearson Education (LPE), 2017
3.	*Introduction to Quantum Mechanics by C.J. Joachain and B.H. Bransden*	Longman Scientific & Technical / John Wiley & Sons Inc., New York, 1989
4.	*Quantum Mechanics: Concepts and Applications by N. Zettili*	Wiley, 2009
5.	*Introduction of Quantum Mechanics by D.J. Griffiths*	Cambridge University Press, 2016
6.	*Principles of Quantum Mechanics by P.A.M.Dirac*	Oxford University Press ,1958
7	*Principles of Quantum Mechanics, R Shankar*	Springer, 1994
8.	*Lectures on Quantum Mechanics by Ashoke Das*	Hindustan Book Agency, 2003
9.	*Quantum Mechanics by John L. Powell and B. Crasemann*	Published by Addison-Wesley, 1965

1.	**Subject Code: MSPH 107**	**Course Title: Applied Optics**
2.	Contact Hours :	L : 3 T : 1 P : 0
3.	Examination Duration (Hrs.) :	Theory : 3 Practical : 0
4.	Relative Weight :	CWS : 25 PRS : 0 MTE : 25 ETE : 100 PRE : 0
5.	Credits :	4
6.	Semester :	ODD
7.	Subject Area :	DCC
8.	Pre-requisite :	Nil
9.	Objective :	To provide foundations in the advanced topics of Optics and some applications in Science and Engineering

10. Details of Course:

1st Semester

S. No.	Contents	Contact Hours
1.	E. M. Waves in a medium: Review of Maxwell's equations and propagation of electromagnetic waves, reflection and refraction of electromagnetic waves, total internal reflection and evanescent waves. Various states of polarization and their analysis, Anisotropic media, Plane waves in anisotropic media, Wave refractive index, Uniaxial crystals, some polarization devices.	**12**
2.	Diffraction: Scalar waves, The diffraction integral, Fresnel and and Fraunhofer diffraction, Single-slit, Double Slit, Diffraction grating, Circular aperture, Resolving power, Diffraction of a Gaussian beam	**10**
3.	Fourier Optics: Basics of Fourier transform operation, Definition of spatial frequency and transmittance function, Fourier transform by diffraction and by lens, Spatial frequency filtering, types of filters, Abbe-Porter experiments, phase-contrast microscope. Holography: Principle of holography, On-axis and off-axis hologram recording and reconstruction, Types of hologram and some applications.	**10**
4.	Coherence and Interferometry: Basics of coherence theory, spatial and temporal coherence, fringe visibility, Michelsonstellar interferometer, Optical beats, Multiple beam interference, The Fabry-Perot interferometer, and its application to spectral analysis. Fourier transform spectroscopy, Laser speckles.	**10**
	Total	**42**

Suggested Books

S. No.	Name of Books/Authors	Year of Publication/ Reprint
1.	*Applied Optics and Optical Design by A. E. Conrady*	New edition, (21 February 1992) Dover Publications Inc.
2.	*Fourier Optics: An Introduction by E. G. Steward*	2nd edition (30 July 2004), Dover Publications Inc.;
3.	*Fundamentals of Photonics by by Bahaa E. A. Saleh and Malvin Carl Teich*	2nd edition (13 April 2007), Wiley-Blackwell
4.	*Optics by Ajoy Ghatak*	Sixth edition (1 July 2017), McGraw Hill Education India Private Limited

1. **Subject Code: MSPH 109**	**Course Title: Electronics**	
2. Contact Hours:	L: 3 T: 1 P: 0	
3. Examination Duration (Hrs):	Theory: 3	Practical: 0
4. Relative Weight:	CWS: 25 PRS: 0 MTE: 25 ETE:100 PRE: 0	
5. Credits:	4	
6. Semester:	ODD	
7. Subject area:	DCC	
8. Pre-requisite:	NIL	
9. Objective:	To make students familiar with basic and advanced analog and digital electronics used in circuit and instrument designing. To provide practical knowledge, electronics based design problems are included.	

10. Detail of Course:

S. No.	Contents	Contact Hours
1.	**Basics of Semiconductor Electronics:** Intrinsic and extrinsic semiconductors, charge densities in p and n type semiconductors, conduction by charge drift and diffusion, the pn-junction, energy level diagrams of pn-junction under forward and reverse bias conditions, derivation of pn-diode equation, Zener and avalanche breakdowns, The bipolar junction transistor basic working principle, configurations and characteristics, Transistor hybrid model, h parameters, Analysis of a Transistor amplifier circuit using h parameters, Hybrid π model, Ebers-Moll model.	**12**
2.	**Field Effect Transistor:** Field-Effect Transistors (FET) Structure, Working, Construction and characteristics of JFET, transfer characteristic, The FET small signal model, Measurement of gm and rd, JFET fixed bias, Self-bias and voltage divider configurations, JFET source follower (Common-Drain) configuration, JFET Common-Gate configuration.	**10**
3.	**Operational Amplifier Basic and Applications:** OP Amp, ideal characteristics, op amp as inverting amplifier, effect of finite open loop gain, generalized basic equation of op amp with impedances, integrator and differentiator, inverting and non-inverting summer, voltage follower. Op Amp parameters, offset voltage and current, slew rate, full wave BW, CMRR. OP AMP as voltage regulator, fixed and variable 3 pin regulator, switching regulator.	**10**
4.	**Digital Electronics and its Application:** Multiplexer, Demultiplexer, Decoder, Encoder, Latches, Flip flops-SR, JK, D, T, and Master Slave –characteristics table and equation-clock timing Diagrams, Edge Triggering-Level Triggering-Realization of one flip Flop using other Flip flops. Shift register, Buffer Registers, Controlled Buffer Registers, Bidirectional shift registers, serial and parallel configuration. Shift register Counters - Ring counter, Johnson counter, Asynchronous ripple or serial counter- Asynchronous Up/Down counter - Presettable Counter, Synchronous counters- Synchronous Up/Down Counter - Decade Counter, Programmable counters.	**10**
	Total	**42**

Suggested Books

S. No.	Name of Books/ Authors	Year of publication/ Reprint
1.	*Electronic Devices and Circuits by Milman and Halkins*	
2.	*Solid State Electronic Devices by Ben G. Streetman*	Seventh Edition, 2015
3.	*Electronics Devices and Circuit theory by Boylested and Nashelsky*	
4.	*Op- Amp and Linear Integrated Circuit by Ramakant A. Gayakwad*	
5.	*Digital Principles and Implementation by A.P. Malvino and D.P. Leach*	

PHYSICS LAB-1: MSPH 111

List of Experiments:

1. To build a Flip- Flop Circuits using elementary gates. (RS, Clocked RS, D-type).
2. To study and verify the operation of 3 to 8-line decoder and 4 to 1-line multiplexer (74138, 74153).
3. Design and set up the BJT CE amplifier using voltage divider bias with and without feedback and determine the gain bandwidth product from its frequency response.
4. Designing of a differentiator using op-amp for a given specification and study its frequency response.
5. To measure the spot size and divergence of a laser beam.
6. To determine the resolving power of a plane transmission grating.
7. To determine the dimensions of a rectangular aperture by its Fraunhofer diffraction pattern.
8. To determine the wavelength of laser source using Michelson's interferometer.
9. Study of Cs-137 spectrum and calculation of FWHM & resolution of given scintillation detector.
10. Study of Co-60 spectrum and calculation of resolution of detector in term of energy.
11. Spectrum analysis of Cs-137 & Co-60 and to explain some of the features of Compton edge and backscatter peak.
12. Measurement of Half value thickness and evaluation of Mass absorption coefficient.

Semester-II

1. **Subject Code: MSPH 102** **Course Title: Advance Quantum Mechanics**
2. Contact Hours: L: 3 T: 1 P: 0
3. Examination Duration (Hrs): Theory: 3 Practical: 0
4. Relative Weight: CWS: 25 PRS: 0 MTE: 25 ETE:100 PRE: 0
5. Credits: 4
6. Semester: EVEN
7. Subject area: DCC
8. Pre-requisite: Knowledge of basic relativistic quantum mechanics.
9. Objective: The aim of the course is to introduce students to the basics of relativistic quantum mechanics, classical and quantum field theories, and quantum theory of radiation.

10. Detail of Course:

S. No.	Contents	Contact Hours
1.	**Relativistic Quantum Mechanics:** Introduction, Klein-Gordan (KG) equation: Plane wave solution, Probability and current densities, KG equation with electromagnetic potentials; Energy levels in a Coulomb field (Hydrogen atom problem). Difficulties of KG equation, Dirac's relativistic equation: Free particle solutions, Dirac matrices and spinors, Probability and current densities, Dirac equation with electromagnetic potentials, Dirac equation for a central field, Existence of spin angular momentum, spin - orbit energy. Energy levels of Hydrogen atom and their classification (Lamb shift).	12
2.	**Field Quantization:** Introduction, Classical and Quantum field equations: Coordinates of the field, Time derivatives, Classical Lagrangian equation, Classical Hamiltonian equations; Quantum equation of the field, Field with more than one component, Complex field, Quantization of the non-relativistic Schrödinger equation (Second quantization): Classical Lagrangian and Hamiltonian equations, Quantum field equations, The N representation, Creation, Destruction and Number operators for Bosons and Fermions, Connection with the many particles Schrödinger equation.	10
3.	**Quantization of Relativistic Fields and Feynman Diagrams:** Natural system of units, Quantization of K-G field, Dirac field and Electromagnetic fields (in vacuum); Lagrangian equations, quantum equations, quantized field energy. Interacting fields and Feynman Diagrams: Introduction, Normal product, Dyson and Wick's chronological products, Contraction, Wick's theorem, Electromagnetic Coupling, The Scattering Matrix, Power series expansion of S-matrix, Scattering processes up to second order.	10
4.	**Quantum theory of radiation:** Classical radiation field, Transversality condition, Fourier decomposition and radiation oscillators, Quantization of radiation oscillators, 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 Raman effect, Radiation damping and Resonance fluorescence.	10
	Total	**42**

Suggested Books

S. No.	Name of Books/ Authors	Year of publication/ Reprint
1.	*Quantum Mechanics by L. I. Schiff*	McGraw-Hill; 3 Rev Ed edition (1968)
2.	*Advance Quantum Mechanics by J. J. Sakurai*	Addison-Wesley, 1967
3.	*Principles of Quantum Mechanics by P.A.M.Dirac*	Oxford University Press ,1958
4.	*Quantum Mechanics by V. K. Thankappan*	New Age International, 1993.
5.	*Quantum Mechanics by A. P. Messiah*	Dover Publications, 2017
6.	*Introduction to Quantum Mechanics by C.J. Joachain and B.H. Bransden*	Longman Scientific & Technical / John Wiley & Sons Inc., New York, 1989
7	*Advanced Quantum Mechanics by B. S. Rajput*	Pragati Prakashan, 1994
8.	*An Introduction to Relativistic Quantum Mechanics by Schweber*	Harper & Row, 1961

1. **Subject Code: MSPH 104**	**Course Title: Statistical Mechanics**	
2. Contact Hours:	L: 3 T: 1 P: 0	
3. Examination Duration (Hrs):	Theory: 3	Practical: 0
4. Relative Weight:	CWS: 25 PRS: 0 MTE: 25 ETE:100 PRE: 0	
5. Credits:	4	
6. Semester:	EVEN	
7. Subject area:	DCC	
8. Pre-requisite:	Knowledge of basic quantum mechanics.	
9. Objective:	This course is intended to provide a firm foundation to students in a very fundamental subject of Statistical Mechanics which aims to derive the macroscopic behaviour of a system in terms of the mechanics of its microscopic constituents, and finds application in almost all branches of Physics.	

10. Detail of Course:

S. No.	Contents	Contact Hours
1.	**Classical Statistical Mechanics:** Foundations of Statistical Mechanics: The macroscopic and microscopic states, Postulate of equal a priori probability, Contact between statistics and thermodynamics; Ensemble theory: Concept of ensemble, Phase space, Density function, Ensemble average, Liouville's theorem, Stationary ensemble; The microcanonical ensemble, Application to the classical ideal gas; The canonical and grand canonical ensembles, Canonical and grand canonical partition functions, Calculation of statistical quantities; Thermodynamics of a system of non-interacting classical harmonic oscillators using canonical ensemble, and of classical ideal gas using grand canonical ensemble, Energy and density fluctuations; Entropy of mixing and the Gibbs paradox, Sackur-Tetrode equation.	**12**
2.	**Quantum Statistical Mechanics:** Quantum-mechanical ensemble theory: Density matrix, Equation of motion for density matrix, Quantum-mechanical ensemble average; Statistics of indistinguishable particles, Two types of quantum statistics- Fermi-Dirac and Bose-Einstein statistics, Fermi-Dirac and Bose-Einstein distribution functions using microcanonical and grand canonical ensembles (ideal gas only), Statistics of occupation numbers; Ideal Bose gas: Internal energy, Equation of state, Bose-Einstein Condensation and its critical conditions; Bose-Einstein condensation in ultra-cold atomic gases: its detection and thermodynamic properties; Ideal Fermi gas: Internal energy, Equation of state, Completely degenerate Fermi gas.	**10**
3.	**Non-Ideal Systems:** Cluster expansion method for a classical gas, Simple cluster integrals, Mayer-Ursell relations, Virial expansion of the equation of state, Van der Waal's equation, Validity of cluster expansion method; Phase transitions: Construction of Ising model, Solution of Ising model in the Bragg-William approximation, Exact solution of the one-dimensional Ising model; Critical exponents, Landau theory of phase transition, Scaling hypothesis.	**10**
4.	**Fluctuations:** Thermodynamic fluctuations and their probability distribution law, Spatial correlations in a fluid, Connection between density fluctuations and spatial correlations; Brownian motion, the Langevin theory of the Brownian motion (derivations of mean square displacement and mean square velocity of Brownian particle), Auto-correlation function and its properties, The fluctuation-dissipation theorem, Diffusion coefficient; the Fokker-Planck equation; Spectral analysis of fluctuations: the Wiener-Khintchine theorem.	**10**
	Total	**42**

Suggested Books

S. No.	Name of Books/ Authors	Year of publication/ Reprint
1.	*Statistical Mechanics by R. K. Pathria*	Academic Press; 3 edition, 2011
2.	*Statistical Mechanics by R. K. Pathria and P. D. Beale*	Academic Press; 3 edition, 2011
3.	*Statistical and Thermal Physics by F. Reif*	McGraw-Hill, 1965
4.	*Statistical Mechanics by K. Huang*	Wiley; Second edition, 2008
5.	*Statistical Mechanics by L. D. Landau and I. M. Lifshitz*	Butterworth-Heinemann, 1980
6.	*Statistical Mechanics by R. Kubo*	North-Holland **Publishing** Company, Amsterdam, 1965

1. **Subject Code: MSPH 106** **Course Title: Computational Methods**
2. Contact Hours: L : 3 T : 1 P : 0
3. Examination Duration (Hrs.): Theory : 3 Practical : 0
4. Relative Weight: CWS : 25 PRS : 0 MTE : 25 ETE : 100 PRE : 0
5. Credits: 4
6. Semester: EVEN
7. Subject Area: DCC
8. Pre-requisite: Nil
9. Objective: To familiarize the students with the numerical techniques to solve the problems related to science and engineering

10. Details of Course:

S. No.	**Contents**	**Contact Hours**
1.	*Errors in numerical calculations*: Introduction, Number and their accuracy, Errors and their analysis, Absolute, Relative, Percentage and Maximum probable error, Physical significance of errors, General error formula *Solution of numerical algebraic and transcendental equation*: Roots of equations, Direct method and iteration method, Bisection method, Regula Falsi Method or Method of False position, Secant or Chord method, Newton-Raphson method, *Solution of simultaneous linear algebraic equation*: Gauss-elimination method, Gauss-Jordon elimination method, Power method, Jacobi method for finding eigen values, Rotation Matrix, Method of triangularization, Relaxation Method	**12**
2.	*Interpolation:* Introduction, Errors in polynomial Interpolation, Finite differences, Detection of errors by use of difference tables, Differences of a polynomial, Interpolation with equally spaced data points: Newton's forward and backward formulae for interpolation, Central difference: Gauss forward, Gauss Backward, Stirling, Bessels, Everett's formula for interpolation, Interpolation with unequally data points: Lagrange's interpolation formula, Divided differences and their property, Newton Divided differences formula	**12**
3.	*Numerical Differentiation and Integration*: Numerical Differentiation formula to find out derivative using data table, maximum and minimum values of a tabulated data, Numerical integration, Newton-cotes integration formulae, trapezoidal method, Simpson's 1/3-rule, Simpson's 3/8-rule, Boole's and Weddle's Rule, Romberg integration, , Euler-Maclaurin formula, Gaussian integration, Numerical double integration	**10**
4.	*Numerical solution of ordinary differential equations*: Introduction, solution by Taylor's series, Picard's method of successive approximation methods, Euler's method, modified Euler's method, Runge-Kutta method, predictor-corrector method, solution of second order and simultaneous differential equations, Application of optimization and variational methods to problem of interest in applied physics	**08**
	Total	**42**

Suggested Books

S. No.	***Name of Books/Authors***	***Year of Publication/ Reprint***
1	*Numerical Methods for Engineers by Steven C. Chapra and Raymond P Canale*	*1998/ McGraw-Hill International Editions*
2	*An Introduction to Computational Physics by Tao Pang*	*2010/Cambridge University Press*
3	*Numerical Methods for Engineers and Scientists by Amos Gilat*	*2008/John Wiley & Sons*
4	*Applied Numerical Analysis by Gerald and Wheatley*	*2003/Pearson*
5	*Numerical methods for Scientific and Engineering Computation by Jain Iyengar and Jain*	*2009/New Age*

1. Subject Code: MSPH 108	**Course Title: Electrodynamics**
2. Contact Hours:	L: 3 T: 1 P: 0
3. Examination Duration (Hrs):	Theory: 3 Practical: 0
4. Relative Weight:	CWS: 25 PRS: 0 MTE: 25 ETE:100 PRE: 0
5. Credits:	4
6. Semester:	EVEN
7. Subject area:	DCC
8. Pre-requisite:	NIL
9. Objective:	To apprise the students regarding the concepts of electrodynamics and Maxwell equations and use them various practical situations

10. Detail of Course:

S. No.	Contents	Contact Hours
1.	**Maxwell`s equations and Electromagnetic wave propagation:** Maxwells equations. Continuity Equation. Lorentz force. Poynting theorem. Conservation of energy and momentum. Scalar and vector potentials. Gauge transformations. Coulomb and Lorentz gauge. Fresnel's laws of reflection and refraction, surface impedance of metals, wave propagation in plasmas, electromagnetic waves in wave guides, anomalous dispersion and negative refractive index.	**10**
2.	**Relativistic formulation of Maxwell's equations:** Review of Special Theory of Relativity (STR) and its application to electromagnetic theory: Conceptual basis of STR. Four-vectors, Tensors. Lorentz transformation as 4-vector transformations. Transformation properties of electric and magnetic fields. E.M. field tensor. Covariance of Maxwell's equations (from tensorial arguments).	**12**
3.	**Relativistic and Non-Relativistic Charged Particle Dynamics in Electromagnetic Fields:** Motion in uniform static magnetic field, uniform static electric field and crossed electric and magnetic fields. Particle drifts (velocity and curvature) in non-uniform static magnetic fields.	**8**
4.	**Radiation:** Green function for relativistic wave equation. Radiation from localized oscillating charges. Near and far zone fields. Multipole expansion. Dipole and quadrupole radiation. Centrefed linear antenna. Radiation from an accelerated point charge. Lienard-Wiechert potentials. Power radiated by a point charge: Lienard's formula and its nonrelativistic limit (Larmor's formula).	**12**
	Total	**42**

Suggested Books

S. No.	*Name of Books/ Authors*	Year of publication/ Reprint
1.	*Classical Electrodynamics* by John David Jackson	3rd Ed.,Wiley, 1998
2.	*Introduction to Electrodynamics* by David Griffiths	3rd Ed.., Benjamin Cummings, 1999
3.	*Principles of Electrodynamics* by Melvin Schwartz.	Dover Publications, 1987
4.	*Classical Electrodynamics by* J. Schwinger, L.L. Deraad Jr, K.A. Milton, W-Y. Tsai and J. Norton	Westview Press, 1998
5.	*Modern Problems in Classical Electrodynamics* by Charles A. Brau.	Oxford Univ. Press, 2003
6.	*Electrodynamics of Continuous Media* by L. D. Landau and E. M. Lifshitz & L. P. Pitaevskii	Oxford, 2005

1. Subject Code: MSPH 110 **Course Title: Solid State Physics**

2. Contact Hours: L: 3 T: 1 P: 0
3. Examination Duration (Hrs): Theory: 3 Practical: 0
4. Relative Weight: CWS: 25 PRS: 0 MTE: 25 ETE:100 PRE: 0
5. Credits: 4
6. Semester: EVEN
7. Subject area: DCC
8. Pre-requisite: Nil
9. Objective: The aim of this course is to familiarise students with basic concepts of solid state physics such as crystal structure, symmetry, lattices, bonding, free electron theory, density of states, magnetism and superconductivity in solids and apply these properties of solids in various scientific and engineering aspects.

10. Detail of Course:

S. No.	Contents	Contact Hours
1.	**Crystallography:** Crystalline and amorphous solids, crystal lattice, Basis vectors, Unit cell, Symmetry operations, Point groups and space groups, Three-dimensional crystal systems, Miller indices, Directions and planes in crystals, Inter-planar spacings, Simple Crystal structures, NaCl, CsCl, Diamond, ZnS and HCP structure, Determination of lattice SC, BCC, FCC, construction of reciprocal lattices, diffraction conditions, Laue equations, Miller indices, relation between miller indices of family of planes, X-ray diffraction by crystals. Laue theory. Interpretation of Laue equations. Bragg's law. Reciprocal lattice. Ewald construction. Atomic scattering factor, structure factor of BCC, FCC, diamond and polyatomic lattice, Experimental methods of x-ray diffraction and applications.	**12**
2.	**Bonding and Imperfections in solid:** Types of bonding, ionic, covalent and Metallic bond, cohesive energy of inert gas solids, cohesive energy and bulk modulus of ionic crystals, Medelung constant, types of imperfections, shear strength of crystals, dislocations, illustration of types of dislocation, burger's vector, role of dislocation in crystal growth, low angle grain boundaries, Experimental method of detecting dislocations and stacking faults.	**10**
3.	**Electronic states of solids:** Review of Sommerfeld model, Boltzmann transport equation, thermodynamic properties due to free electrons, band structure, concept of hole and electrons, Bloch's theorem, density of states, nearly free electron approach and pseudopotentials, electron wave equation in periodic crystal potential, solution of zone boundary and near zone boundary, orbitals in bands, semiconductors and insulators, kronig-penny model, Brillion zones.	**10**
4.	**Magnetism and superconductivity**: Origin of magnetism, Magnetic properties of solids, Diamagnetism, Langevin equation, Quantum theory of paramagnetism, Curie law, Paramagnetism in rare earth and iron group ions, Elementary idea of crystal field effects, Ferromagnetism, Curie-Weiss law, Heisenberg exchange interaction, Anti-ferromagnetism, Neel point, occurrence of superconductivity, Meissner effect, London equation, BCS ground state and energy gap, high temperature superconductors.	**10**
	Total	**42**

Suggested Books:

S. No.	Name of Books/ Authors	Year of publication/ Reprint
1.	*Introduction to Solid State Physics* by C. Kittle,	8th edition Wiley, 2005
2.	*Elements of Solid State Physics* by J.P. Srivastava,	PHI, 2015
3.	*Solid State Physics* by A.J. Dekker,	Macmillan, 2008
4.	*Solid State Physics* by Ashcroft and Mermin	Cengage Learning, 1976
5.	*Elementary Solid State Physics by* Ali Omar,	4th edition, Addison Wesley, 1994
6.	*Introduction to Material Science and Engineering by* W.J. Callister Junior.	John Wiley &Sons Inc, 2000
7.	Solid State Physics by S.O. Pillai	Wiley Eastern Ltd, 1994

PHYSICS LAB-II: MSPH 112

List of Experiments:

1. To determine the Curie temperature of ferrite core and find out loss in energy.
2. To determine the Hall coefficient, type of charge carrier and carrier concentration of a given semi-conductor.
3. To measure the resistivity of a Ge/Si semiconductor using four probe method at different temperature and find its band gap.
4. To investigate the Lattice dynamic for mono-atomic and diatomic chains.
5. Write a Matlab program to find the roots of the equation by bisection method. Compare the result with the Matlab inbuilt function.
6. Write the Matlab program to solve the second order differential equation for solving the pendulum problem.
7. Write Matlab code to plot the intensity distribution of single-slit, double -slit and N-slit all together. Analyze the result. Show how young's double slit experiment is different from the double slit diffraction.
8. Write Matlab code to show the propagation of group wave as a function of time.
9. Study the characteristics of a G.M. tube and determination of its operating voltage, plateau length/ slope etc.
10. Estimation of efficiency of the G.M. detector for a) Gamma source 7 b) Beta source.
11. To study the backscattering of Beta particles and gamma rays.
12. Study of energy resolution characteristics of a scintillation spectrometer as a function of applied high voltage and to determine the best operating voltage.