COURSES OF STUDY
FOR THE
MASTER OF SCIENCE (M. Sc.) EXAMINATION
IN
APPLIED PHYSICS

Department of Physics
Veer Surendra Sai University of Technology, Burla
Samblpur-768018, Odisha

Course Structure of M.Sc. (Applied Physics)

First Year

Course Name	Course Title	L	T	P	Credits
		1st Semester			
MPH- 1101	Classical Mechanics	4	0	0	4
MPH- 1102	Mathematical Physics-I	4	0	0	4
MPH- 1103	Quantum Mechanics-I	4	0	0	4
MPH- 1104	Condensed Matter Physics-I	4	0	0	4
MPH- 1107	Computer Programming in C	4	0	0	4
MPH- 1191	Physics Lab-I (General Physics)	0	0	3	2
MPH- 1192	Programming Lab-I	0	0	3	2
		Total			**24**
		2nd Semester			
MPH- 1201	Statistical Mechanics	4	0	0	4
MPH- 1202	Electrodynamics-I	4	0	0	4
MPH- 1203	Quantum Mechanics-II	4	0	0	4
MPH- 1204	Numerical Techniques in Physics	4	0	0	4
MPH- 1209	Basic Electronics	4	0	0	4
MPH- 1291	Physics Lab-II (Laser and Photonics)	0	0	3	2
MPH- 1292	Programming Lab-II	0	0	3	2
		Total			**24**

Second year

Course Name	Course Title	L	T	P	Credits
3rd Semester					
MPH- 1301	Electrodynamics-II	4	0	0	4
MPH- 1302	Mathematical Physics-II	4	0	0	4
MPH- 1303	Condensed matter Physics II	4	0	0	4
MPH- 1304	Spectroscopy	4	0	0	4
MPH- 1305	Nuclear & Particle Physics	4	0	0	4
MPH- 1391	Physics Lab-III (Modern Physics)	0	0	3	2
MPH- 1392	Seminar & Technical Writing-I	0	0	3	2
		Total			**24**
4th Semester					
MPH- 1401	Experimental Techniques in Physics	4	0	0	4
MPH- 1402	Elective-I	4	0	0	4
MPH- 1403	Elective-II	4	0	0	4
MPH- 1491	Physics Lab-IV (Advanced Materials)	0	0	3	2
MPH- 1492	Seminar & Technical Writing-II	0	0	3	2
MPH- 1493	Project	0	0	3	6
MPH- 1494	Comprehensive Viva-Voce	0	0	0	2
		Total			**24**

Electives:

1. Physics of Semiconductor Devices
2. Materials Science
3. Crystallography
4. Fibre Optics
5. Cosmology and Astrophysics
6. Nuclear Technology
7. Laser Physics
8. Nano Technology
9. Quantum Field Theory

First Semester

MPH-1101: Classical Mechanics 3 1 0 4

Unit-I

Review: Application of Newton's Laws and Conservation Laws; Lagrangian Dynamics: Mechanics of a system of particles, constraints, classification, D' Alemberts principle; generalized coordinates, Lagrange's equations, applications. Variational calculus and Least Action principle.

Unit-II

Central force problem: Equations of motion, orbits, Virial theorem, Kepler problem, scattering in a central force field. Rigid body motion: Orthogonal transformations, Euler angles, coriolis effect, angular momentum and kinetic energy, tensors and dyadic, inertia tensor, Euler equations, applications, heavy symmetrical top.

Unit-III

Hamiltonian formulation: Legendre transformations, Hamilton equations, cyclic coordinates and conservation theorems, principle of least action,

Unit-IV

Canonical transformations, Poisson brackets, Langrange brackets, Hamilton-Jacobi theory, Action-angle variables.

Unit-V

Small oscillations: Eigenvalue problem, frequencies of free vibrations and normal modes, forced vibrations, dissipation.Classical field theory: Lagrangian and Hamiltonian formulation of continuous system.

Text books and References:

1. H. Goldstein, Classical Mechanics, 2nd Edition, Narosa, (1985).
2. L. Landau and E. Lifshitz, Mechanics, Oxford (1981).
3. F. Scheck, Mechanics, Springer (1994).
4. N.L. Rana and P.S. Joag , Classical Mechanics (TMH,1991)
5. Classical mechanics – S.N.Gupta, V.Kumar and H.V.Sharma, Pragati prakasan,1985, New Delhi

MPH-1102: Mathematical physics -I 3 1 0 4

Unit-I

Ordinary Differential Equations: First order ODE's – Separable ODE's – Orthogonal trajectories –Second order linear ODE's – Differential operators – Higher order linear ODE's – Homogeneous and inhomogeneous differential equations

Unit-II

Series solution of ODE's – Frobenius method – StrumLiouvllie problem – Orthogonal eigen function expansions, Legendre, Hermite, Bessel and special functions

Unit-III

Partial Differential Equations

Introduction to partial differential equations – Introduction to curvilinear coordinates – Cylindrical polar and spherical polar systems – Review of vector calculus – Divergence, curl and Grad in polar system – Solution by analytical methods – Solution of (i) Laplace, (ii) Poisson, (iii) Helmholtz wave and (iv) diffusion equations in Cartesian and polar coordinate systems.

Unit-IV

Complex Variables Elements of analytic function theory – Cauchy Riemann conditions – Singularities, poles and essential singularities – Cauchy's integral theorem – Cauchy integral formula – Residue theorem and contour integration Residue method for real integration

Unit-V

Taylor and Maclaurin expansion – Laurent and Taylor series of complex functions – Introduction to conformal mapping. Special Functions Beta, Gamma, Delta and Error functions

Textbooks and References:

1. G. Arfken, Mathematical Methods for Physicists (5th Edition) (Academic Press, 2000).
2. Erwin Kreyszig (2005). Advanced Engineering Mathematics. 9th Edition. John Wiley.
3. R.K. Jain, S.R.K. Iyengar (2007). Advanced Engineering Mathematics. 3rd Edition. Narosa.
4. K. F. Riley, M. P. Hobson and S. J. Bence, Mathematical Methods for physics and engineering (Cambridge Univ. Press, 1998)
5. M. P. Boas (2005). Mathematical Methods in the Physical Sciences (3rd Edition) Wiley.
6. Potter M C and Goldberg J (1988). Mathematical Methods. Prentice Hall.
7. Sokolnikoff I S and Redheffer R M. Mathematics of Physics and Modern Engineering. Mc Graw Hill.
8. Spiegel M R. Theory and Problems of Complex Variable. Schaum’s Series. McGraw Hill.
9. Spiegel M R. Theory and Problems of Fourier analysis. Schaum’s Series. McGraw Hill.

MPH-1103: Quantum Mechanics-I 3 1 0 4

Unit-I
Introduction to Quantum Theory: Wave-Particle duality, matter waves, group velocity, phase velocity, uncertainty principle, wave packets.Basic postulates of quantum mechanics, concept of probability and probability current density

Unit-II
Schrodinger equation. Operators, eigenvalues and eigenfunctions.Simple potential problems: Particle in a box, steps, barriers, wells, bound states, delta function potential,

Unit-III
Schrodinger Equation for Central Potential: Hydrogen atom, power series solution for the radial part, energy quantization, quantum numbers, Laguerre polynomials, 3-dimensional harmonic oscillator.

Unit-IV
Matrix formulation of Quantum Mechanics: Linear and matrix algebra, Dirac's bra and ket notation, matrix representations of vectors and operators, expectation values, different representations in quantum mechanics, parity operation. Matrix theory of harmonic oscillator.

Unit-V
Theory of Angular Momentum: Spherical harmonics, eigenvalues for L^2, *Lz*, commutation relations, quantum numbers, degeneracies. C.G. coefficients

Textbooks and References

1. S. Gasiorowicz, Quantum Physics, John Wiley (Asia) (2000).
2. P. W. Mathews and K. Venkatesan, A Textbook of Quantum Mechanics, Tata McGraw Hill
3. F. Schwabl, Quantum Mechanics, Narosa (1998).
4. L. 1. Schiff, Quantum Mechanics, Mcgraw-Hill (1968).
5. E. Merzbacher, Quantum Mechanics, John Wiley (Asia) (1999).
6. B. H. Bransden and C. J. Joachain, Introduction to Quantum Mechanics, Longman (1993)

MPH-1104: Condensed Matter Physics -I 3 1 0 4

Unit-I

Crystal physics: Symmetry operations; Bravais lattices; Point and space groups; Miller indices and reciprocal lattice; Structure determination; diffraction; X-ray, electron and neutron; Crystal binding; Defects in crystals; Point and line defects.

Unit-II

Lattice vibration and thermal properties: Einstein and Debye models; continuous solid; linear lattice; acoustic and optical modes; dispersion relation; attenuation; density of states; phonons and quantization; Brillouin zones; thermal conductivity of metals and insulators.

Unit-III

Electronic properties: Free electron theory of metals; electrons in a periodic potential; Bloch equation; Kronig-Penny model; band theory; metal, semiconductor and insulators; bandgap; intrinsic and extrinsic semiconductors, Hall Effect, p-n junction.

Unit-IV

Dielectrics: Polarizability; Clausius-Mossotti formula; Dielectric constant; ferroelectrics.
Magnetism: Diamagnetism, paramagnetis'm, ferromagnetism, antiferro magnetism and ferrimagnaetism.

Unit-V

Superconductivity: Meissner effect; London equations; coherence length; type-I and typeII superconductors.

Text books and References:

1. C. Kittel, Introduction to Solid State Physics, John Wiley (1996).
2. A. J. Dekker, Solid State Physics, Macmillan (1986).
3. N. W. Ashcroft and N. D. Mermin, Solid State Physics, HBC Publ., (1976).
4. H. P. Myers, Introduction to Solid State Physics, Viva books (1998).
5. M.A. Omar, Elementary Solid State Physics, Addison-Wesley (1975).

MPH-1107: Computer Programming in C 3 1 0 4

Introduction to personal computers and operating systems (DOS/Windows & Linux), graphics packages.
C Programming Language: Control system Data structure – Identifiers and Keywords – Constants, Variables and Data types – Operators and expressions – Data Input and Output – Control Structures – *if* and *switch* statements – *while*, *do-while* and *for* statements – *goto* statement – Arrays – Character strings – Simple programs
Functions and Pointers
User defined Functions – Defining and accessing functions – Passing arguments – Function prototypes – Recursion – Storage classes – Pointer Declarations – Passing pointers to functions – Pointers and arrays – Operations on pointers – Arrays of pointers
Structures, Unions and Data Files
User defined data types – Structures – Declaring structures and Accessing members – Array of structures – Structure within structure – Unions – File operations – open, close, reading and writing – Random access files – Linked list – Preprocessor directives – Macros – Command line arguments
Solving simple problems using C programming Language.
Solution of Equations and Interpolation Bisection, iterative and Newton Raphson method for finding roots of the equations – solution of simultaneous linear equation by Gauss elimination and Gauss Seidal method – finite differences – Newton's forward difference interpolation formula.
Integration and Ordinary Differential Equations Trapezoidal rule – Simpson's 1/3 rule – Solution of ordinary differential equation by Euler method – Runge-Kutta second order and fourth order method.

Text books and References

1. V. Rajaraman, Computer programming in C, Prentice-Hall (2000).
2. M. M. Mano, Computer System Architecture, Prentice Hall (1993).
3. P. Norton, Complete Guide to Windows, Prentice Hall (1995).
4. K.Srirengan, Understanding Unix, Prentice Hall (1999).
5. B. W. Kernighan and D. M. Ritchie, The C Programming Language, Prentice-Hall (2001).
6. Byron S. Gottfried, Schaum's outline of Theory and Problems of Programming with C, Tata McGraw-Hill 7. Bjarne Stroustroup, The C++ Programming Language, 2nd edition, Addison-Wesley (1991).
8. E. Balagurusamy, Numerical Methods, Tata McGraw-Hill, New Delhi (1999).
9. S.S. Sastry, Introductory Methods of Numerical Analysis, 4th edition, Prentice Hall of India (2005).

MPH-1191: Physics Laboratory-I 0 0 3 2

1. Hall Effect in Semiconductor
2. Non-Destructive Testing – Ultrasonics
3. Two Probe Method for Resistivity Measurement.
4. Wavelength Measurement of Laser using Diffraction Grating.
5. Op-Amp Arithmetic Operations
6. Op-Amp Square, Ramp Generator and Wien Bridge Oscillator
7. Op-Amp Precision Full Wave Rectifier
8. Numerical Aperture of an Optical Fiber
9. Combinational Logic Circuit Design
10. UJT Characteristics

References :

1. R.A. Dunlap, Experimental Physics: Modern Methods, Oxford University Press, New Delhi (1988).
2. B.K. Jones, Electronics for Experimentation and Research, Prentice-Hall (1986).
3. P.B. Zbar and A.P. Malvino, Basic Electronics: A Text-Lab Manual, Tata Mc-Graw Hill, New Delhi.

MPH-1192: Computer Programming Lab 0 0 3 2

A. Exercises for acquaintance: (Using C/FORTRAN 90)

1. To find the largest or smallest of a given set of numbers.
2. Bubble sort.
3. Division of two complex numbers (treating a complex number as an ordered pair of reals).
4. To generate and print first hundred prime numbers.
5. To generate and print an odd ordered magic square.
6. Transpose of a square matrix using only one array.
7. Matrix multiplication.
8. Raising a real number to a large integer power.
9. Fibonacci search.
10. Merging of files.

B. Numerical Analysis :

1. Lagrange Interpolation.
2. Divided difference interpolation.
3. Binary search.
4. Regula falsi.
5. To locate the extrema of a function.
6. Evaluation of Bessel Functions.
7. Newton-Raphson Method.
8. Method of successive approximations.
9. Secant method.

Simultaneous equations :

1. Gaussian Elimination.
2. Gauss-Seidel method.

Least Squares Approximation :

1. Linear fit.
2. Fitting an exponential.
3. Fitting a trigonometric function.

Numerical Integration :

1. Simpson’s rule.
2. Gaussian Quadrature.
3. And experiments similar to the above.

Second Semester

MPH-1201: Statistical Mechanics 3 1 0 4

Unit-I
Review of Thermodynamics: Laws of thermodynamics, entropy, potentials.
Statistical Thermodynamics: Macroscopic and microscopic states, connection between statistics and thermodynamics, classical ideal gas, entropy of mixing and Gibb's paradox.

Unit-II
Ensemble Theory: Phase space, Liouville's theorem, microcanonical ensemble, examples,quantum states and phase space;Canonical Ensemble: Equilibrium, partition function, energy fluctuation, equipartition and Virial theorem, harmonic oscillators, statistics of paramagnetism; Grand Canonical Ensemble: Equilibrium, partition function, density and energy fluctuation, correspondence with other ensembles, examples.

Unit-III
Formulation of Quantum Statistics: Quantum mechanical ensemble theory, density Matrix, statistics of various ensembles, examples.Theory of Simple Gasses: Ideal gas in different quantum mechanical ensembles. Systems of: monatomic, diatomic and polyatomic molecules.

Unit-IV
Ideal Bose Gas: Thermodynamics, Bose-Einstein condensation, blackbody radiation, phonons, Helium II.

Unit-V
Ideal Fermi Gas: Thermodynamics, Pauli paramagnetism, Landau diamagnetism, DeHassVan Alphen Effect, thermionic and photoelectric emissions, white dwarfs.
Interacting Systems: Cluster expansion, Virial Expansion, evaluation of Virial coefficients.

Text books and References:

1. R. K. Pathria, *Statistical Mechanics*, Butterworth-Heinemann (1996).
2. F. Reif, *Statistical and Thermal Physics*, McGraw-Hill (1985).
3. W. Greiner, L Neise, and H. Stocker, *Thermodynamics and Statistical Mechanics*, Springer
4. K. Huang, *Statistical Mechanics*, John Wiley Asia (2000).
5. L. D. Landau and E. M. Lifshitz, *Statistical Physic~I*, Pergamon (1980).

MPH-1209: Basic Electronics 3 1 0 4

Unit-I
Analog electronics: Network theorems; application to simple circuits.
p-n junction devices, diode, transistors; biasing schemes; small signal amplifiers; feed-back theory; oscillators; power supply; wave shaping circuits.

Unit-II
JFET and MOSFET characteristics and small signal amplifier.

Unit-III
OP-AMP: Differential amplifiers; Op-Amp (741) circuits (amplifiers; scalar; summer; subtractor; comparator; logarithmic amplifiers; multiplier; divider; differentiator, integrator; analog computer; wave shapers; oscillators).
Multivibrators: Astable, monostable and bistable MV using BJT and IC555.

Unit-IV
Digital electronics: number systems; decimal, binary, octal and hexadecimal system arithmetics;
logic families; logic gates; Boolean algebra;

Unit-V
De Morgan's laws; simplifying Boolean expressions; arithmetic circuits (adders, subtractor); flip-flops; registers; counters; memories, A/D and D / A conversion: resolution and speed; various circuits.

Text books and References

1. A. Mottershead, Electronic Devices and Circuits, Prentice Hall of India (1993).
2. J. Millman and C. C. Halkias, Integrated Electronics, Tata McGraw Hill (1995).
3.R. Gaekwad, Op-Amps and Linear Integrated Circuits, Prentice Hall of India (1995).
4. A. P.Malvino and D. P. Leach, Digital Principles and Applications, Tata McGraw Hill (1991).
5.R. S. Gaonkar, Microprocessor Architecture: Programming and Applications with the 8085,Penram India

MPH1202: Electrodynamics - I 3 1 0 4

Unit-I

Electrostatics: Continuous Charge Distribution, Delta Function, Field and Potential, Poisson and Laplace's equations, Boundary Conditions and Uniqueness theorems, Electrostatic potential energy, Capacitance, Conductors.

Unit-II

Boundary Value Problems: Solution of Laplace and Poisson equations in 2 & 3 dimensions.
Method of images, separation of variables in Cartesian, Cylindrical and Spherical coordinate systems, Multipole expansion, Green's function approach.

Unit-III

Dielectrics: Polarization, bound charges, susceptibility, energy and force, boundary conditions,boundary value problems.

Unit-IV

Magnetostatics: Biot-Savert's Law, Ampere's law, vector potential, magnetic field, moments, force, torque and energy of localized current distributions. Boundary conditions, boundary value problems.
Electrodynamics: Electromotive force, Ohm's law, Faraday's law, self and mutual inductance, energy in magnetic fields, Maxwell's equations, Gauge transformations, potential formulation,energy and momentum conservation, Poynting theorem.

Unit-V

Electromagnetic Waves: Wave equation, Propagation of electromagnetic waves in non conducting medium, reflection, transmission, Snell's law, Brewster's angle, critical angle, Dispersion in non conducting medium.

Text books and References:

1. J. D. Jackson, Classical Electrodynamics, John Wiley (Asia) (1999).
2. J. R. Reitz and F. J. Millford, Foundation of Electromagnetic Theory, Narosa (1986).
3. W. Greiner, Classical Electrodynamics, Springer (1998).
4. L. D. Landau and E. M. Lifshitz, Electrodynamics of Continuous Media, Butterworth

MPH-1203: Quantum Mechanics-II 3 1 0 4

Unit-I

Perturbation Theory: Non-degenerate and Degenerate Cases. applications: Zeeman and Stark effects. Induced electric dipole moment of Hydrogen

Real Hydrogen Atom: Relativistic correction, spin-orbit coupling, hyperfine interaction, Helium atom, exclusion principle, exchange interaction.

Unit-II

Schrodinger equation for a slowly varying potential, WKB approximation, turning points, connection formulae, derivation of Bohr-Sommerfeld quantization condition, applications of WKB.

Unit-III

Time Dependent Perturbation Theory: Sinusoidal perturbation, Fermi's Golden Rule, special topics in radiation theory, semi-classical treatment of interaction of radiation with matter,

Einstein's coefficients, spontaneous and stimulated emission and absorption, application to lasers.

Unit-IV

Scattering Theory: Born Approximation, scattering cross section, Greens functions. Scattering for different kinds of potentials, applications.

Unit-V

Relativistic Invariance, Dirac equation, solution of free field Dirac equation, Klein-Gordon equation.

Quantisation of fields: Quantum field equations, creation, annihilation and number operators, occupation number representation, Fermi, Bose and Boltzman statistics

Text books and References:

1. S. Gasiorowicz, Quantum Physics, John Wiley (Asia) (2000).
2. E. Merzbacher, Quantum Mechanics, John Wiley (Asia) (1999).
3. P. W. Mathews and K. Venkatesan, A Textbook of Quantum Mechanics, Tata McGraw Hill (1995).
4. F. Schwabl, Quantum Mechanics, Narosa (1998).
5. L. I. Schiff, Quantum Mechanics, Mcgraw-Hill(1968).
6. B. H. Bransden and C. J. Joachain, Introduction to Quantum Mechanics, Longman (1993)

MPH-12 04: Numerical Techniques in Physics 3 1 0 4

Unit-I

Errors: Its sources, propagation and analysis, computer representation of numbers. Roots of Nonlinear Equations: Bisection, Newton-Raphson, secant method. System of Nonlinear equations, Newton's method for Nonlinear systems. Applications in Physics problems.

Unit-II

Solution of linear systems: Gauss, Gauss-Jordan elimination, matrix inversion and LU decomposition. Eigenvalues and Eigenvectors. Applications.

Interpolation and Curve fitting: Introduction to interpolation, Lagrange approximation, Newton and Chebyshev polynomials. Least square fitting, linear and nonlinear. Application in Physics problems.

Unit-III

Numerical Differentiation and Integration: Approximating the derivative, numerical differentiation formulas, introduction to quadrature, trapezoidal and Simpson's rule, Gauss-Legendre integration. Applications.

Unit-IV

Solution of ODE: Initial value and boundary value problems, Euler's and Runge-,Kutta methods, Finite difference method. Applications in Chaotic dynamics, Schrodinger equations.

Unit-V

Solution of PDE: Hyperbolic, Parabolic, and Elliptic Equations by finite difference. Application to 2-dimensional Electrostatic Field problems.

Text book and References:

1. K. E. Atkinson, Numerical Analysis, John Wiley (Asia) (2004).
2. S. C. Chapra and R. P. Canale, Numerical Methods for Engineers, Tata McGraw Hill (2002).
3. J. H. Mathews, Numerical Methods for Mathematics, Science, and Engineering, Prentice Hall of India
4. S. S. M. Wong, Computational Methods in Physics, World Scientific (1992).
5. W. H. Press, S. A. Teukolsky, W. T. Verlling and B. P. Flannery, Numerical Recipes in C,Cambridge
6. Richard Hamming. Numerical Methods for Scientists and Engineers. Dover publications.
7. J.M. Thijssen (1999). Computational Physics. Cambridge University Press.
8. Tao Pang (1997). An Introduction to computational physics. Cambridge University Press.
9. Rubin H. Landau (1997). Computational Physics: Problem solving with computers. John Wiley.
10. James B. Scarborough. Numerical mathematical analysis. Oxford IBH.

MPH-1291: Physics Laboratory-II 0 0 3 2

1. Michelson Interferometer
2. Forbe's Method
3. Fourier Filtering
4. Photo-diode Characteristics
5. Elastics Constants – Elliptical and Hyperbolic Fringes
6. Hysteresis (B – H Curve)
7. Helmholtz Galvanometer
8. ESR Spectroscopy
9. Conductivity of Thin Film – Four Probe Method
10. Solar-Cell Characteristics
11. Quincke's Method
12. Curie Temperature of Magnetic Materials
13. Dielectric Constant and Curie Temperature of Ferroelectric Ceramics

References

1. R.A. Dunlap, Experimental Physics: Modern Methods, Oxford University Press, New Delhi (1988).
2. B.K. Jones, Electronics for Experimentation and Research, Prentice-Hall (1986).
3. P.B. Zbar and A.P. Malvino, Basic Electronics: A Text-Lab Manual, Tata Mc-Graw Hill, N. Delhi

MPH-1292: Computer Programming Lab 0 0 3 2

Matlab Fundamentals

Introduction-Matlab Features-Desktop Windows: Command, Workspace, Command History, Array Editor and Current Directory -Matlab Help and Demos- Matlab Functions, Characters,Operators and Commands.

Basic Arithmetic in Matlab-Basic Operations with Scalars, Vectors and Arrays-Matrices andMatrix Operations-Complex Numbers- Matlab Built-In Functions-Illustrative Examples

Matlab Programming

Control Flow Statements: *if, else, else if, switch* Statements-*for*, *while* Loop Structures-*break* Statement-Input/Output Commands-Function m Files-Script m Files-Controlling Output

Matlab Graphics:

2D Plots-Planar Plots, Log Plots, Scatter Plots, Contour Plots-Multiple Figures, Graph of a Function-Titles, Labels, Text in a Graph- Line Types, Marker types, Colors-3D Graphics-Curve Plots-Mesh and Surface Plots-Illustrative Examples

Text books and References:

1. Engineering and Scientific Computations Using Matlab- Sergey E. Lyshevski-JohnWiley & Sons
2. A Guide to Matlab for Beginners & Experienced Users-Brian Hunt, Ronald Lipsman, Jonathan Rosenberg-Cambridge University Press
3. Matlab Primer-Timothy A. Davis & Kermit Sigmon-Chapman & Hall CRC Press- London
4. Matlab Programming-David Kuncicky-Prentice Hall
5. Getting Started With Matlab-Rudra Pratap-Oxford University Press-New Delhi
6. An Introduction to Programming and Numerical Methods in MATLAB- S.R. Otto and J.P. Denier-Springer-Verlag-London
7. Numerical Methods Using Matlab-John Mathews & Kurtis Fink-Prentice Hall-New Jersey
8. Numerical methods in Science and Engineering**-** M.K. Venkataraman-NationalPublishing Co. Madras
9. Introductory Methods of Numerical Analysis- S.S. Sastry-Prentice Hall

Third Semester

MPH-1301: Electrodynamics - II 3 1 0 4

Unit-I
Electromagntic Waves in Conducting medium: Reflection and transmission, frequency dependence of permittivity, permeability and conductivity, electrons in conductors and plasma.

Unit-II
Wave Guides: Waves between parallel conductors, TE and TM waves, Rectangular and Cylindrical wave guides.
Radiations: Moving Charges, Lienard- Wiechert potential, accelerated charges, angular distribution of radiations, distribution of frequency and energy, Thomson's scattering, Bremsstrahlung in Coulomb collisions.

Unit-III
Radiating Systems and Multipole fields: Electric dipole fields and radiations, quadrupole fields, multipole expansion, Energy, angular momentum, multipole radiations.

Unit-IV
Scattering and Diffraction: Scattering at long wavelengths, perturbation theory, Rayleigh scattering, diffraction theory-Kirchhoff's integral and applications.

Unit-V
Special Theory of Relativity: Lorentz Transformations and it's consequences, conservation laws, mass energy relation, relativistic momentum and energy, relativistic force. Relativistic Electrodynamics: Covariant formalism of Maxwell's equations, Transformation laws and their physical significance, relativistic generalization of Larmor's formula, Relativistic formulation of radiation by single moving charge.

Text books and References:
1. J. D. Jackson, Classical Electrodynamics, John Wiley (Asia) (1999).
2. R. Resnick, Introduction to Special Relativity John Wiley (Asia) (1999)
3. E. C. Jordan and K. G. Balmain, Electromagnetic Waves and Radiating Systems, Prentice Hall (1995).
4. J. Schwinger et aI, Classical Electrodynamics, Persesus Books (1998).
5. G. S. Smith, Clasical Electromagnetic Radiation, Cambridge (1997).

MPH-1302: Mathematical Physics -II 3 1 0 4

Unit-I

Linear Algebra

Linear vector spaces – Dual space – Basis sets – Orthogonality and completeness – Hilbert space – Linear operators – Self adjointed unitary operators – Families of orthogonal polynomials as basis sets in function space – Rotation group in 2 and 3 dimensions – Pauli matrices – Generators of rotations.

Matrices: Inverse of a marix, Orthoginal matrix, Rotation, similarity transformation, Eigen values and eigen vectors, secular equations, Caley-Hamilton theorem, Matrix diagonalization

Unit-II

Laplace Transforms

Laplace transforms – Inverse transforms – Linearity and Shifting theorems – Laplace transform of derivative of a function – Laplace transform of integral of a function – Unitstep function – *t*shifting – Short impulses –Diracdelta function – Convolution – Integral equations – Application to solve differential equations.

Fourier Transforms Introduction to Fourier analysis – Half range Fourier series – Harmonic analysis and applications – Forced oscillations – Finite and infinite Fourier transforms – Fourier sine and cosine transforms – Complex Fourier transforms – Fourier expansion and inversion formulas – Convolution theorem – Applications to solutions of partial differential equations.

Unit-III

Vectors Rotation group in 2 and 3 dimensions – Pauli matrices – Generators of rotations – Scalars, vectors and tensors in index notation – Del and Laplacian operators – Vector calculus in index notation– Dirac delta function

Unit-IV

Tensors: Representation and properties – Algebra of Cartesian tensors – Outer product – Contraction and quotient theorems – Kronecker & LeviCivita tensors – Example – Applications in Physics.

Unit-V

Group Theory

Concept, sub groups, conjugate elements and classes, Permutaton groups, Caley's theorem, representation of groups, Orthogonality theorems, Unitary group, Point group

Text books and References

1. G. Arfken, Mathematical Methods for Physicists (5th Edition) (Academic Press, 2000).
2. Erwin Kreyszig (2005). Advanced Engineering Mathematics. 9th Edition. John Wiley.
3. R.K. Jain, S.R.K. Iyengar (2007). Advanced Engineering Mathematics. 3rd Edition. Narosa.
4. K. F. Riley, M. P. Hobson and S. J. Bence, Mathematical Methods for physics and engineering (Cambridge Univ. Press, 1998)
5. M. P. Boas (2005). Mathematical Methods in the Physical Sciences (3rd Edition) Wiley.
6. Potter M C and Goldberg J (1988). Mathematical Methods. Prentice Hall.
7. Sokolnikoff I S and Redheffer R M. Mathematics of Physics and Modern Engineering. McGraw Hill.
8. Spiegel M R. Theory and Problems of Complex Variable. Schaum's Series. McGraw Hill.
9. Spiegel M R. Theory and Problems of Fourier analysis. Schaum's Series. McGraw Hill.

MPH-1303: Condensed Matter Physics-II 3 1 0 4

Unit-I

Optical Properties : Resume of macroscopic theory -- generalized susceptibility,Kramers- Kronig relations, Brillouin scattering, Raman effect; interband transitions.(Books 1-4)

Unit-II

Magnetism : Dia- and para-magnetism in materials, Pauli paramagnetism, Exchange interaction. Heisenberg Hamiltonian and resume of the results; Ferro-, ferri- and antiferro-magnetism; spin waves; specific heat - Bloch law.(Books 2-4).

Unit-III

Magnetic Resonance Techniques : Principles of ESR and NMR(Book 1)

Unit-IV

Superconductivity : Experimental Survey, Basic phenomenology, Type I and Type IIsuperconductors; BCS pairing mechanism,; High Tc superconductors.(Books 1-4).

Unit-V

Disordered Solids : Resume of point defects and dislocations; Non-crystalline solids:diffraction pattern, glasses, amorphous semiconductors and ferromagnets, heat capacity and thermal conductivity of amorphous solids, Brief introduction to nanostructures.

Text books and References:

1. Introduction to Solid State Physics : C. Kittel (Wiley, New York).
2. Quantum Theory of Solids : C. Kittel (Wiley, New York).
3. Principles of the Theory of Solids : J. Ziman (Cambridge University Press,Cambridge).
4. Solid State Physics : H. Ibach and H. Luth (Springer, Berlin).
5. A Quantum Approach to Solids : P.L. Taylor (Prentice-Hall, Englewood Cliffs).
6. Intermediate Quantum Theory of Solids : A.O.E. Animalu (East-West Press, New Delhi).
7. Solid State Physics : Ashcroft and Mermin (Reinhert & Winston, Berlin).

MPH-1304: Spectroscopy 3 1 0 4

Unit-I

Review of one-electron and two-electron atoms: Schrodinger equation, para and ortho states, Pauli exclusion principle, Excited states, doubly exciteq states, Auger effect, resonance.

Many electron atoms: Central field approximation, Thomas-Fermi model, Hartee-Fock method and self-consistent field, Hund's rule, L-S and j-j cuopling.

Interaction with Electromagnetic fields: Selection rules, spectra of alkalis, Helium and alkaline earths, multiplet structure, Zeeman and Stark effect.

Unit-II

Molecular structure: General nature, Born-Oppenheimer separation, rotation and vibration of diatomic molecules, electronic structure of diatomic molecules, structure of polyatomic molecules.

Molecular spectra: Rotational, vibrational, electronic spectra of diatomic molecules, electronic spin and Hund's cases and nuclear spin, Raman and Infra-Red spectrums.

Atomic collisions: Types of collisions, channels, thresholds, cross-sections, potential scattering, general features, Born approximation.

Unit-III

IR Spectroscopy: Practical Aspects-Theory of IR Rotation Vibration Spectra of Gaseous Diatomic Molecules-Applications-Basic Principles of FTIR Spectroscopy.

Raman Spectroscopy: Classical and Quantum Theory of Raman Effect-Rotation Vibration Raman Spectra of Diatomic and Polyatomic Molecules-Applications-Laser Raman Spectroscopy.

Unit-IV

NMR Spectroscopy: Quantum Mechanical and Classical Description-Bloch Equation-Relaxation Processes-Experimental Technique-Principle and Working of High Resolution NMR Spectrometer-Chemical Shift

NQR Spectroscopy: Fundamental Requirements-General Principle-Experimental Detection of NQR Frequencies-Interpretation and Chemical Explanation of NQR Spectroscopy

Unit-V

ESR Spectroscopy: Basic Principles-Experiments-ESR Spectrometer-Reflection Cavity and Microwave Bridge-ESR Spectrum-Hyperfine Structure

Mossabauer Spectroscopy: Mossabauer Effect-Recoilless Emission and Absorption-Mossabauer Spectrum-Experimental Methods-Hyperfine Interaction-Chemical Isomer Shift-Magnetic Hyperfine and Electric Quadrupole Interaction

Text books and References:

1. B. H. Bransden and C. J. Joachain, Physics of Atoms and Molecules, Longman (1996).
2. G. K. Woodgate, Elementary Atomic Structure, Clarendon Press (1989).
3. F. L. Pilar, Elemntary Quantum Chemistry, McGraw Hill (1990).
4. H. E. White, Introduction to Atomic Spectra, Tata McGraw Hill (1934).
5. C. N. Banwell and E. M. McCash, Fundamentals of Molecular Spectroscopy, Tata McGrawHill (1994)
6. Concepts of Nuclear Physics-Bernard L. Cohen-Tata McGraw Hill- New Delhi
7. Introductory Nuclear Physics-Kenneth S. Krane-John Wiley & Sons
8. Nuclear Physics-J.C. Tayal-Umesh Prakashan-Gujarat
9. Physics of Nucleus and Particles-Volume I & II-B. Nermeir & Sheldon
10. Introduction to molecular spectroscopy - G.M.Barrow
11. Spectroscopy: Volumes I, II and III-B.P. Straugham & S. Walker
12. Atomic Physics - J.B.Rajam, S.Chand Publications.

MPH-1305: Nuclear and Particle Physics 3 1 0 4

Unit-I
Nuclear properties: radius, size, mass, spin, moments, abundance of nuclei, binding energy, excited states.
Nuclear forces: deuteron, n-n and p-p interaction, nature of nuclear force.
Nuclear Models: liquid drop, shell and collective models.

Unit-II
Nuclear decay and radioactivity: radioactive decay, detection of nuclear radiation, alpha, beta and gamma decays, radioactive dating.

Unit-III
Nuclear reactions: conservation laws, energetics, isospin, reaction cross section, Coulomb scattering, nuclear scattering, scattering cross section, optical model, compound nucleus, direct reactions, resonance reactions, neutron physics, fission, fusion.
Unit-IV
Particle accelerators and detectors: electrostatic accelerators, cyclotron, synchrotron, linear accelerators, colliding bean accelerators, gas-filled counters, scintillation detectors, semiconductor detectors.

Unit-V
Elementary particles: forces, quantum numbers, mesons and Yukawa's hypothesis, pions, CPT theorem, strange mesons and baryons, production and decay of resonances, CP violation in K decay.
Particle physics: Symmetries and conservation laws, Feynman diagrams, Gell-MannNishijima relation, Quark model, coloured quarks and gluons, quark dynamics, standard model.

Text book and References:

1. K. S. Krane, Introductory Nuclear Physics, John Wiley (1988).
2. R. R. Roy and B. P. Nigam, Nuclear Physics: Theory and Experiment, New Age (1967).
3. A. Das and T. Ferbel, Introduction to nuclear and particle physics, John Wiley (1994).
4. I. S. Hughes, Elementary Particles, Cambridge (1991).
5. F. Halzen and A. D. Martin, Quarks and Leptons, John Wiley (1984).

MPH-1391 Physics Laboratory-III 0 0 3 2

MPH-1392: Seminar and Technical writing 0 0 3 2

Fourth Semester

MPH-1401: Experimental Techniques in Physics 3 1 0 4

Unit-I
Sensors: Resistive, capacitative, inductive, electromagnetic, thermoelectric, elastic, piezoelectric, piezoresistive, photosensitive and electrochemical sensors; interfacing sensors and data acquisition using serial and parallel ports.
Unit-II
Low pressure: Rotary, sorption, oil diffusion, turbo molecular, getter and cryo pumps; Mcleod, thermoelectric (thermocouple, thermister and pirani), penning, hot cathode and Bayard Alpert gauges; partial pressure measurement; leak detection; gas flow through pipes and apertures;effective pump speed; vacuum components.
Unit-III
Low temperature: Gas liquifiers; Cryo-fluid baths; liquid He cryostat design; closed cycle He refrigerator; low temperature measurement.
Unit-IV
Analytical Instruments: X-ray diffractometer; Spectrophotometers; FT-IR; DSC; lock-in amplifier; spectrum analyzer, fluorescence and Raman spectrometer, scanning electron microscope, atomic force microscope, interferometers.

Unit-V
Laboratory component: physical parameter measurement using different sensors; low pressure generation and measurement; calibration of secondary gauges; cryostat design; CCR operation; data collection from analytical instruments in the department.

Text books References:
1. A. D. Helfrick and W. D. Cooper, Modern electronic instrumentation and measurement techniques, Prentice Hall of India (1996).
2. J. P. Bentley, Principles of measurement systems, Longman (2000).
3.G. K. White, Experimental techniques in low temperature physics, Calrendon (1993).
4. A. Roth, Vacuum technology, Elsevier (1990).
5. D. A. Skoog, F. J. Holler and T. A. Nieman, Principles of Instrumental analysis, Saunders CoI. Pub

MPH-1402: Elective-I 3 1 0 4

MPH-1403: Elective-I I 3 1 0 4

MPH-1491 Physics Laboratory-IV 0 0 3 2

MPH-1492: Seminar and Technical writing 0 0 3 2

MPH-1493: Project 0 0 3 6

MPH-1494: Comprehensive viva-voce 0 0 0 2

Elective papers

1. Physics of Semiconductor Devices

Energy Band Structure, occupation probabilities, Impurities and Imperfection in Semiconductors, carrier concentration in thermal equilibrium, Electron Transport Phenomenon, Thermal Effects in Semiconductors, Excess Carriers in semiconductors, recombination, contact phenomenon, Photoconductivity, Photovoltaic Effect, Scattering Process in Semiconductors:
Optical and high frequency effects in semiconductors, Semiconducting Materials, Amorphous semiconductors, structural and electronic properties, applications of amorphous semiconductors.

Text books and References:

1. R. A. Smith, Semiconductors, Academic Press (1978).
2. K. Seeger, Semiconductor Physics: An introduction, Springer Verlag (1991).
3. C. Hamaguchi, Basic semiconductor physics, Springer verlag (2001).
4. J. Singh, Physics of semiconductors, Tata Mcgraw Hill (1993).
5. K. Morigaki, Physics of Amorphhous Semiconductor, Imperial college Press (1999).

2. Materials Science

Short review of basic structures, Tetrahedral and octahedral sites and their properties and importance, substitutional and interstitial solid solutions (only definitions), coordination number and Pauling rules, Crystal Structures of metallic alloys, Ceramics, polymers, silicates, composite materials etc. This include structures such as NaCl, CsCl, Rutile, flurite, corrundum, Hexagonal and cubic zink Blende,NiAS, Perovskine, spinel and inverse spinel, quartz, silicates (linkages of tetrahedral and octahedralunits), glass, polymers etc.,
Physical Thermodynamics including topics such as Laws of thermodynamics, internal energy,reversible and irreversible reactions (with reference to materials phase transitions), heat of formation, concept of entropy, derivation of expression for configurational entropy using concept of multiplicity, micro and macrostates etc., free energies, chemical potential, derivation of various thermodynamical expressions, concepts of eqillibrium and metastability, Phase diagrams of elements, applications of thermodynamics, Clapeyron and Clauses-Clapeyron equations for phase transitions, vapor pressures, effect of temperatures, its importance to vacuum systems and materials evaporation for thin films.
Defects in Materials : point defects, line defects (dislocations), surface defects (grain boundaries),volume defects (voids), defects formation energies, their impact on physical properties of materials, formation energies, defect creation and annihilation, thermodynamic aspects such as concentration and interactions, stress fields, Burger vector, slip and glide motions of dislocations, calculation of surface energies and its importance etc.
Phase Diagrams : Concepts of solid solubility, Hume-Rothery rules, concept of formation of phase diagrams on basis of entropy and free energy changes for compositions, Phase diagrams of various categories such as that of limited solubility, eutectic, peritectic etc. with examples, intermetallicalloys etc.
Diffusion in solids : concentration gradients, steady state non steady state flow, Fick’s laws, error functions, diffusivity (macroscopic and microscopic diffusion models), importance of diffusion formaterials synthesis and processing, examples and applications such as oxidation, corrosion, carborization, decarborization, nitridation, Nernst-Einstein equation, concentration profiles, etc. Heat Treatment and Phase transformations in solids : Variation of free energies, nucleation and growth, surface and volume free-energies, Quenching, Nucleation rate, growth rates derivation of related expressions, T-T-T diagrams, applications of nucleation and growth and precipitation reactions.

Text Books and References:

1. Physical Metallurgy, Vol. 1 & Vol. 2 by R. W. Chan and P. Hassen North Holland Pub.Co, NY, 1983.
2. Materials Science and Engineering, V. Raghvan, (Prentice-Hall Pvt. Ltd.), 1989.
3. Introduction to Materials Science for Engineers,
J. F. Shackelford, (Macmillan Publishing Company, New York), 1985.
4. Physical Metallurgy, Smallman.

3. Crystallography

Symmetry of crystals, crystal projection and point groups, space groups, determination of space groups.
Production of X-Ray, X-Ray generator, absorption of X-Rays and principle of filter. Scattering of X-Ray by an electron, an atom and a unit cell, atomic scattering factor and structurefactor. Diffraction of X-Rays, Laue and Bragg equation, X-Ray powder diffraction, determination of lattice parameters by Debye-Scherrer method, X-Ray diffractometer, X-Ray line profile analysisbroadening of diffraction line, size and strain broadening, scherrer equation, residual stress, chemical analysis by XRD, X-Ray fluorescence, chemical analysis by X-Ray fluorescence, neutron and electron diffraction. introduction to small Angle X-ray Scattering (SAXS) and its advantage in structure evaluation; Introduction to X-ray spectroscopy, Moseley’s law and its applications, x-ray fluorescence (XRF), energy dispersive x-ray (EDX), particle induced x-ray emission (PIXE) and their applications; Introduction to medical x-ray and x-ray techniques (radiography, radiotherapy, CT scanning etc.)
Reciprocal lattice, sphere of reflection, Oscillation and Weisenberg photograph and their interpretation, determination of lattice parameters by using Oscillation photographs, layer lines and rho lines.
Fourier Series representation of electron density in crystals, projection of electron density in two dimensions, electron density contours.Phase problem and its solutions, trial and error method, Patterson function, Heavy atom method, Isomorphous replacement method, Direct methods, Use of Harker-Kasper inequalities, convolution multiplication theorem. Refinement, agreement residual factor, differential synthesis and method of least squares

Text Books and references:

1. Elements of X-ray diffraction - B.D. Cullity
2. The interpretation of X-ray diffraction photograph, - N.F.M. Henry, H. Lipson and W.A. Wooster
3. X-ray Crystallography - Verma and Srivastava
4. X-ray Diffraction procedures - H.P. Klug and L.E. Alexander
5. Fourier Transform and X-ray diffraction H.Lipson and C.A. Taylor
6. Crystal Structure Analysis – M.J. Burger
7. Structure determination by X-ray Crystallography - M.F.C. Ladd and R.A. Palmer
10. X-ray diffraction-its theory and applications - S.K. Chatterjee
11. Structure of materials - Marc De Graef and M.E. Mc Henry
12. J. A. Nielson and D. McMorrow, Elements of Modern X-ray physics, John Wiley&sons, 2001.
13. G. V. Pavlinsky, Fundamentals of x-ray physics, Cambridge International sci Pub, 2008.
14. A. K. Singh, Advanced X-ray Techniques in Research and Industry, Capital Publishing Company,
15. N. Kasai, M. Kakudo, X-ray diffraction by macromolecules, Springer, 2005.

4. Fibre Optics

Fiber optic fundamentals – Numerical aperture – attenuation in optical fibers – pulsed dispersion in step index optical fiber – Loss mechanisms – absorptive loss – radiative loss- Principle of optical waveguides – Characteristics of fibers – pulsed dispersion in planar optical waveguide – Modes in planar waveguides – TE,TM modes – propagation characteristics of a Step index fiber and Graded index optical fiber.
Intensity-Modulated Sensors – Transmission concept – reflective concept – microbending concept-intrinsic concepts – transmission and reflection with other optical effects – source of error and compensation schemes. Phase modulation mechanisms in optical fibers- optical fiber interferometers – optical fiber phase sensors for mechanical variables – the optical fiber sagnac interferometer – optical fiber interferometric sensors Frequency modulation in optical fiber sensors – introduction – optical fiber Doppler system – development of the basic concepts. Polarization modulation in fiber sensors- introduction – optical activity – faraday rotation – electro-gyration – electro-optic effect- kerr effect – photoelastic effect – polarization modulation sensors. Wavelength distribution sensor – introduction – techniques for colour modulation – colour probes. Bragg grating concept – introduction – fabrication – application.

Text books and References:

1. K. Okamoto, Fundamentals of Optical Waveguides, Academic Press (2000).
2. A. K. Ghatak and K. Thyagarajan, Introduction to Fiber Optics, Cambrid~e (1999).
3. N. S. Kapany, Fiber Optics: Principles and Applications, Academic Press l1998).
4. G. Keiser, Optical Fibre communication, McGraw **Hill** (1991).
5. D.A.Krohn, Fiber Optic Sensors: Fundamentals and Applications, Second Edition, Instrument Society of America (1992).
6. B.Culshaw, Optical Fiber Sensing and Signal Processing, Peter Peregrinus Ltd. (1984).
7. Djafar K.Mynbaev and Lowell L.Scheiner, Fiber-Optic Communications Technology, Pearson Education

5. Cosmology and Astrophysics .

Astrophysics

Overview of the Universe : Qualitative description of interesting astronomical objects, (from planets to large scale structures), Length, Mass and Timescales, Physical conditions in different objects,
Evolution of structures in the universe, red-shift. Radiation in different bands, Astronomical Jargon;
Astronomical measurements in different bands, current sensitivities and resolution availableGravity : Newtonian gravity and basic potential theory, Simple orbits – Kepler's laws and precession, flat rotation curve of galaxies and implications for dark matter, virial theorem and simple applications, role of gravity in different astrophysical systems.

Radiative Processes : Overview of radiation theory and Larmor formula, Different radiative processes : Thomson and Compton scattering, Bremsstrahlung, Synchrotron [detailed derivations are not expected] Radiative equilibrium, Planck spectrum and properties; line widths and transition rates in QT of radiation, qualitative description of which radiative processes contribute in which waveband/astrophysical system, distribution function for photons and its moments, elementary notion of radiation transport through a slab, concept of opacities.

Gas Dynamics : Equations of fluid dynamics; equation of state in different regimes [including degenerate systems]; Models for different systems in equilibrium, Application to White dwarfs/Neutron stars, Simple fluid flows including supersonic flow, example of SN explosions and its different phases.

Basic equations of stellar structure, Stellar energy sources; qualitative description of numerical
solutions for stars of different mass, homologous stellar models, Stellar evolution, Evolution in the HR-Diagram.

Milky Way Galaxy, Spiral and Elliptical galaxies, Galaxies as self gravitating systems; spiral structure, Supermassive black holes, Active galactic nuclei.

Cosmolgy

Cosmological Models : Cosmological Principles, Robertson-Walker metric, cosmological redshift, Hubble's law, Observable quantities-luminosity and angular diameter distances. Dynamics of Friedmann-Robertson-Walker models.

Solutions of Einstein's equations for closed, open and flat Universes.

Physical Cosmology and the Early Universe: Thermal History of the Universe: Temperature-redshift relation, distribution functions in the early Universe-relativistic and non-relativistic limits. Decoupling of neutrions and the relic neutrino background-Nucleosynthesis. Decoupling of matter and radiation;
Cosmic microwave background radiation. Inflation-Origin and growth of Density Perturbations.

Text books and References:

1. General Relativity and Cosmology, J. V. Narlikar, (Macmillan company of India Ltd., Delhi).
2. Classical Theory of Fields, Vol. 2, L. D. Landau and E. M. Lifshitz, (Pergamon Press, Oxford).
3. First course in general relativity, B. F. Schutz, (Cambridge University Press).
4. Introduction to Cosmology, J. V. Narlikar, (Cambridge University Press).
5. Modern Astrophysics, B. W. Carroo and D. A. Ostlie, (Addison-Weseley).
6. The physical universe, F. Shu, (University Science books).
7. The Physics of Astrophysics, Volume I and II, F. Shu, (University Science books).
8. Theoretical Astophysics, Volumes I, II and III,
9. T. Padmanabhan, (Cambridge University Press).
10. The Physics of fluids and plasmas, Arnab Rai Choudhuri, (Cambridge University Press).
11. Astrophysical concepts, M. Harwitt, Springer-Verlag.
12. Galactic Astronomy, J. Binney and M. Merrifeld, (Princeton University Press).
13. Galactic dynamics, J. Binney and S. Tremaine, (Princeton University Press).
14. Quasars and Active Galactic Nuclei, A. K. Kembhavi and J. V. Narlikar, (C U Press).
11. An Introduction to Active Galactic Nucleii, B. M. Peterson.

6. **Nuclear Technology**

Interaction of radiation with matter : General description of interaction processes, interactions of directly ionizing radiation, stopping power, linear energy transfer, range of particles, interaction of indirectly ionizing radiation attenuation coefficient, energy transfer, build up factor.
Relation detectors Gaseous ionization, ionization and transport phenomena in gases, avalanche multiplication, cylindrical and multiwire proportional counters, drift chamber, scintillator detectors, general characteristics of organic and inorganic scintillators, detection efficiency for various types of radiation, scintillators, detection efficiency for various types of radiation, scintillation detector mounting, photomultiplier gain, stability, semiconductor detectors, basic principle, surface barrier detector, Si(Li), Gel(Li), HPGe and position sensitive detectors.
Pulse processing and related electronics : Preamplifier, amplifier, pulse shaping networks, biased amplifier, pulse stretchers delay lines.
Pulse height analysis and coincidence technique: Single channel analyzer, multichannel analyzer, pulse height spectroscopy, pulse shape discrimination, coincidence units, slow-fast coincidence circuits.
Timing methods and systems : Walk and fitter, time pick off methods, digital timing methods, introduction to CAMAC systems. Multichannel Analyzer Applications of radiation, gamma-ray and neutron radiography.
Dosimetry and radiation protection : Units kerma, Cema, energy deposit and energy imparted, absorbeddose, main aims of radiation protection, dose equivalent and quality factor, organ dose, effective dose equivalent effects and dose limits, assessment of exposure from natural man-made sources.

Text Books and references:

1. Nuclear radiation detectors, S. S. Kappor and V. S. Rmanurthy. (Wiley Eastern, New Delhi) 1986.
2. Introduction to radiation protection dosimetry, J. Sabol and P. S. Weng, (World Scientific),1995.
3. Techniques for nuclear and particle physics, W. R. Len (Springer), 1955.
4. Nuclear Measurement Techniques, K. Sriram, (Affiliated East-West Press, New Delhi), 1986.
5. Fundamentals of surface and thin film analysis, L. C. Feldman and J W. Mayer, (Nor Hol, NY), 1988.
6. Intro. to nuclear science and technology, K. Sriram and Y. R. Waghamare, (A. M. Wheeler), 1991.
7. Nuclear radiation detection, W. J. Price, (McGraw-Hill, New York), 1964.
8. Alphas, beta and gamma-ray spectroscopy, K. Siegbahn, (North Holland, Amsterdam), 1965.
9. Introduction to experimental nuclear physics, R. M. Singru, (John Wiley and Sons), 1974.
10. Radioactive isotopes in biological research, Willaim. R. Hendee, (John Wiley and Sons), 1973.

7. Laser Physics

Laser Fundamentals: spontaneous and stimulated emission, Einstein coeffecients, population inversion – Properties: temporal and spatial coherence, directionality – Types: Ruby laser, Helium Neon laser, CO_2 Laser, Dye Lasers, Semiconductor lasers.

Holography Spatial Frequency Filtering – Holography – Applications of holography – HNDT (Holographic Non-Destructive Testing) holographic storage – optical disk storage – Laser speckle and speckle meteorology – SNDT (Speckle Non-Destructive Testing).

Fibre Optics Optical fibre principle – types of fibres –properties- fiber optical communication-fibre amplifiers, Fiber-optic sensors: intensity-phase- polarization and frequency dependent techniques

Lasers in Science Saturation spectroscopy – excited state spectroscopy – nonlinear spectroscopy – time domain and its applications – stimulated Raman Emission – Laser fusion – Isotope separation – Medical applications, photo-chemical applications Lasers in industry Materials processing – drilling, cutting, welding – alloying – glazing – oblation – laser chemical vapour deposition (LCVD) – laser thermal deposition – hardening, annealing – Laser Tracking – Lidar.

Text books and References

1. K. Thyagarajan and A.K. Ghatak, Lasers Theory and Applications, Mcmillan (1981).
2. K. Koebner (ed.), Industrial Applications of Lasers, Wiley (1984).
3. J.T. Cuxon and D.E. Parker, Industrial Lasers and their Applications, Prentice Hall (1985).
4. B. Culshaw, Optical Fiber Sensing and Signal Processing, Peter Peregrinus Ltd. (1984).
5. F.C. Appard, Fiber Optics Handbook, McGraw-Hill (1989).
6. O. Svelto, Principles of Laser, Plenum (1998).
7. W. T. Silfvast, Laser and Fundamentals, Cambridge (1996).
8. A. E. Seigman, Lasers, Oxford (1986).
9. A. Yariv, Quantum Electronics, John Wiley (1988).

8. Nanotechnology

Nanomaterials and Structures *Nanomaterials and types:* Nanowires, Nanotubes, Fullerenes, Quantum Dots, Nanocomposites – Properties – *Methods of preparation:* Top Down , Bottom Up.
Characterization Tools Electron Microscopy Techniques – SEM, TEM, X ray methods – Optical Methods Fluorescence Microscopy – Atomic Force Microscopy, STM and SPM.21
Nanomagnetism Mesoscopic magnetism – Magnetic measurements: Miniature Hall Detectors, Integrated DC SQUID Microsusceptometry – Magnetic recording technology, Biological Magnets.
Nanoelectronics and Integrated Systems Basics of nanoelectronics – Single Electron Transistor – Quantum Computation – tools of micro-nanofabrication – nanolithography – quantum electronic devices – MEMS and NEMS – Dynamics of NEMS – limits of integrated electronics. Unit – V: Biomedical Applications of Nanotechnology Biological structures and functions – Drug delivery systems – organic-inorganic nanohybrids – Inorganic carriers – Nanofluidics.

Text books and References :

1. Jan Korvink & Andreas Greiner, Semiconductors for Micro and Nanotechnology – an Introduction for Engineers, Weinheim Cambridge: Wiley-VCH (2001).
2. N John Dinardo, Weinheim Cambridge, Nanoscale Characterisation of Surfaces & Interfaces, 2nd edition, Wiley-VCH (2000).
3. G Timp (ed), Nanotechnology, AIP press, Springer (1999).
4. M. Wilson, K. Kannangara, G. Smith, M. Simmons and B. Raguse, Nanotechnology: Basic Sciences and Energy Technologies, Overseas Press (2005).
5. G. L. Hornyak, H. F. Tibbals, J. Dutta, H. F. Tibbals, *Introduction to nanoscience*, Taylor and Francis Inc, 2008.
6. Z. L. Wang, Y. Liu, Z. Zhang, *Handbook of Nanophase and nano structured materials Vol-I Synthesis*, Klwer Academic Publications, 2002.
7. T. Pradeep, *Nano: The essentials: Understanding Nanoscience &Nanotechnology*, McGraw-Hill professional publishing (1st Edn).
8. T. Chakraborty, F. Peeters, U. Sivan, *Nano-physics & Bio-electronics: A new Odyssey*, Elsevier Publications, 2002.

9. Quantum Field Theory

Action principle, Cannonical Transformations, Poisson Brackets, Symmetries and conservation laws, Green's functions, Klein Gordon equation, Dirac equation, Free propogators Quantization of fields, Real and charged scalars, Massless and massive vector and spinor fields Perturbation Theory, Feynman Rules, Regularization schemes, Renormalizability, Renormalization group equations, QED and Electro-weak Interactions.

Text books References:

1. C. Itzykson and J. B. Zuber, Quantum Field Theory, McGraw Hill (1985).
2. P. Ramond, Field Theory: A Modern Primer, Addison-Wesley (1990).
3. T. P. Cheng and L. F. Li, Gauge Theory of Elementary Particle Physics, Clarendon Press,Oxford, 1984.
4. K. Huang, Quantum Field Theory From Operators to Path Integrals, John Wiley (1998).

No: VSSUT/PHY/ Dated: 06-09-2010

To

The Dean Academic Affairs

V S S University of Technology, Burla

Sambalpur-768018

Sub: Submission of Syllabus and Course structure for MSc Physics Programme.

Ref: Letter No: VSSUT/ACD/589(11) dated 31st August 2010

Sir,

With reference to above letter, please find herewith one set of hard copy and one set of soft copy of the syllabus and course structure of the MSc (Physics) Programme.

HOD (Physics)