Semester-I

MS/ES-101: MATHEMATICAL METHODS FOR PHYSICS

UNIT-1: LINEAR ALGEBRA AND MATRICES (PERIODS-8 Hours)

Vector spaces, basis vectors, the inner product, some inequalities, linear operators and their properties, Matrices- the Eigen value problem, determination of eigenvalues Eigen functions, digonalisation, trace and normalization of matrix, Caley-Hamiltonian theorem.

UHIT-2: SPECIAL FUNCTIONS (PERIODS-10 Hours)

Legendre equation, Reylign formula, generating function, orthogonality, hermits polynomial, Rodriguez formula, recurrence relation, generating function, orthogonality,Laguerres equation, Rodriguez formula, generating function, orthogonality, Bessel equation, generating function, recurrence relation, orthogonality.

UNIT-3:FOURIER SERIES (PERIOD-8 Hours)

Fourier series- periodic function, Euler Fourier formula, Dirichilete conditions, half range Fourier series, change of interval, Parsevals identity, alternate forms of the Fourier series, application of Fourier series- vibrating string, RLC circuit

UNIT-4: FOURIER TRANSFORM AND LAPLACE TRANSFORM (PERIOD-8 Hours)

Integral transform- Fourier integral and Fourier transform, few examples, the Dirac delta function, properties of Fourier transform, odd and even function, convolution and deconvolution theorem, Parsevals therom, Laplace transform, Laplace transform of derivatives and integrals, properties of the Laplace transform,

UNIT-5: ELEMENTS OF COMPLEX ANALYSIS (PERIOD-7 Hours)

Analytic functions, Cauchy Riemann condition, contour integrals , Laurent series, the residue theorem, method of finding the residues, evaluation of definite integrals

UNIT-6: ELEMENTARY PROBABILITY THEORY (PERIOD-7 Hours)

A definition of the probability sample space, permutation and combination, fundamental probability theorems, random variables, and probability distributions, special probability distribution, binomial, Poisson, normal

REFERENCE BOOKS:-

1 Mathematical Methods for Physicists – Tai L. Chow

1st Edition, 2000, Cambridge University Press

2 Mathematical Methods For Physics And Engineers- Riley, Hobson And Bence,

1st Edition, 1997, Cambridge University Presses.

3 Mathematical Methods In Physical Sciences- M.L.Boas

3rd Edition, 2006, Wily India Education

4 Matrices And Tensors In Physics- A.W. Joshi

3rd Edition, New Age International (P) Ltd.

5 Complex Variables-M.R.Spiegel

McGraw Hill Book Company

6 Mathematical Methods for Physicists-G.B Arfken, H. J.Weber, 5th Edition,

Harcourt Pvt. Ltd. (Academic Press)

MS/ES-102: CLASSICAL MECHANICS

UNIT-1: ENERGY AND WORK (08 hours)

Conservative force, potential energy, conservative momentum and angular momentum, conservative system of particles of mass, motion of COM, conservation theorems & equation of motion under different types of forces.

UNIT-2: THE LANGRANGIAN FORMULATION OF MECHANICS (10 hours)

Generalized coordinates, DoF, configurational space, constraints, D'Alembert's principle and Lagrange's equations, kinetic energy in generalized coordinates, generalized momentum and energy. Gauge function for the Lagrangian, gauge invariance, cyclic or ignorable coordinates.

UNIT-3: HAMILTONIAN DYNAMICS (10 hours)

Hamilton's principle and Lagrange's equations, Lagrange's equation for non-holonomic systems, few examples of Lagange's equation of motion, method of undetermined multipliers, the Hamiltonian of the dynamical system, Hamilton's canonical equations, Integrals of Hamilton's equations, canonical transformations, Poission bracket, phase space, Lagrange from Hamiltonian, few application of Hamiltonian formulation.

UNIT-4: CENTRAL FORCE MOTION (10 hours)

The two body problem and the reduced mass, general properties of central force motion, effective potential and classification of orbits, general solutions, inverse square law of the force, Kepler's law of planetary motion.

UNIT-5: COUPLED OSCILATIONS (10 hours)

Coupled pendulum, normal coordinates, coupled oscillators and normal oscillators, and normal modes, equation of motion of a coupled system, normal modes of oscillation, orthogonality of Eigen vectors, normal coordinates, forced oscillations of coupled oscillator, coupled oscillator circuits, vibration of loaded string, vibrating string and the wave equations.

Reference Books:

1. Classical Mechanics- T.L.Chow

1st Edition, 1995, John Willey and Sons Inc.

2. Classical Mechanics – Takwale, Puranic

1st Edition, 2007, Tata McGraw Hill Publication

3. Classical Mechanics- H.Goldstein

2nd, Edition, 1980, Narosa Publishing House

4. Classical Mechanics- Rana and Joag

1st Edition, Tata McGraw Hill Company Ltd.

5. Classical Mechanics: A Modern Perspective- Barger and Olsson

2nd Edition, 1995, McGraw Hill Publication

MS/ES-103: ELECTRONICS

UNIT-1: PHYSICS OF SEMICONDUCTORs (PERIOD – 5 Hours)

Density of states and and its application to the semiconductors, Fermi-Dirac distribution & its characteristics, equilibrium distribution of electrons and holes in intrinsic and extrinsic semiconductors , position of Fermi energy level, its variation with doping concentration and temperature.

UNIT-2: THE P-N JUNCTION (PERIOD – 7 Hours)

Basic structure of p-n junction, built in potential barrier, electronic field, space charge width, reverse applied bias, junction capacitance, frequency response, load lines, diode applications: clipping-clamping circuits

UNIT-3: BI-JUNCTION TRANSISTORS (PERIOD – 8 Hours)

Transistor biasing: base bias , emitter bias, voltage divider bias, applications, BJT

amplifiers, configurations: CE, CC, CB, load line analysis, amplifier AC equivalent

circuits, ac analysis of transistors: small signal analysis, H parameters.

UNIT-4: FIELD EFFECT DEVICES (PERIOD – 7 Hours)

The JFET biasing, working principle, drain curves, transceductance curves, JFET

approximations, the depletion and enhancement mode MOSFET, basic idea and device characteristics, applications, JFET analog switch, MOSFET amplifiers and switches, introduction to CMOS.

UNIT-5: OPTOELECTRONIC DEVICES (PERIOD – 7 Hours)

Optical absorption, photon absorption coefficient, electron hole pair generation, solar cell : the I-V characteristics, p-n junction solar cell, conversion efficiency , the hetero junction solar cell, photo detectors, photodiode, pin photodiode, avalanche photodiode, phototransistors, light emitting diodes, generation of light, internal and external quantum efficiency, laser diodes, stimulated emission and population inversion.

UNIT-6: OPERATIONAL AMPLIFIER (PERIOD - 7 Hours)

Operation overview, differential amplifiers and OPAMP specifications, modes of operations, input output parameters, frequency response, integrators, differentiator, summing negative and positive feedback.

UNIT- 7: DIGITAL ELECTRONICS (PERIOD - 7 Hours)

Flip-flops: RS, D, T, JK, MS., shift resistors, counting, synchronous and asynchronous counters, ADC and DAC, 2-2R network, binary ladder

Reference Books:

1. Semiconductor Physics And Devices- Donald A. Neaman

3rd Edition, 2007, Tata McGraw Hill Company.

2. Electronic Principles- A. Malvino, D.J. Bates

7th Edition, 2008, Tata McGraw-Hill Publication Pvt Ltd.

3. Introductory Electronic Devices And Circuits- Painter

2nd Edition, 1991, New Jerky; Regents/Prentice Hall

4. Electronic Fundamentals And Applications-J.D.Ryder

5th Edition, 1990, Prentice Hall of India Pvt. Ltd.

MS/ES-104: QUANTUM MECHANICS-I

UNIT-1: THE ORIGIN OF QUANTUM THEORY (PERIODS-08 Hours)

Inadequacy of classical Physics, de Broglie hypothesis, wave-particle duality, Born's interpretation of wave function, wave function for particle momentum, wave packets, the Heisenberg's uncertainty principle.

UNIT-2: SCHRODINGER EQUATION (PERIODS-08 Hours)

Necessity of wave equation and the conditions imposed on it, time dependent Schrodinger equation, Conservation of probability, Expectation values, Ehrenfest theorem, time independent Schrodinger equation, Eigen functions and Eigen values, Stationary states, orthogonality of eigen functions, parity, continuity and boundary conditions.

UNIT-3:ONE DIMENSIONAL ENERGY EIGEN VALUE PROBLEMS(PERIOD-10 Hour)

Free particle, infinite square well, potential step, square potential barrier, explanation of alpha decay, square well potential, Linear harmonic oscillator.

UNIT-4: FORMALISM OF QUANTUM MECHANICS (PERIOD-12 Hours)

Postulates of quantum mechanics, representation of states and dynamical variables, observables, self-adjoint operators, eigen functions and eigen values, degeneracy, orthogonality, orthonormality, completeness and closure property, physical interpretation of eigen values, eigen functions and expansion coefficients, eigen values and eigen functions of momentum operator, Dirac's bra and ket notations, linear operators, unit operator, hermitian operator, unity operator, parity operator, eigen values and eigen functions of simple harmonic oscillators by operator method.

UNIT-5: ANGULAR MOMENTUM (PERIOD-10 Hours)

Orbital angular momentum, angular momentum algebra, angular momentum as a

generator of infinitesimal rotations, Eigen values and functions of L_2 and L_z, adder

operators L- and L+, spin angular momentum, Pauli's spin matrices, addition of angular momenta, representation of J in ljm> basis, computation of Clebsch-Gordan coefficients in simple cases (J_1=1/2, J_2=1/2).

References:

1.) Quantum Mechanics: B. H. Bransden and C. J. Joachain, 2nd Edition, 2004,

Pearson Education ltd.

2.) Quantum Mechanics: L. I. Schiff, 3rd edition, 1998, MGH book company.

3.) Quantum Mechanics: J. D. Powell and B. Crossman. 1st edition, 1998, Narosa

Publishing House.

4.) Quantum Mechanics: S. Gasiorowicz, 3rd edition, 2003, Wiley International.

Semester-II

MS/ES-201: QUANTUM MECHANICS-II

UNIT-1: CENTRAL POTENTIAL (PERIODS-08 Hours)

Separation of the Schrodinger equation in spherical polar co-ordinates, the hydrogen atom, energy levels, the Eigenfunction of the bound states.

UNIT-2: TIME INDEPENDENT PERTURBATION THEORY (PERIODS-10 Hours)

Time independent perturbation theory: Non-degenerate and degenerate cases (upto 2^{nd} order). Applications: anharmonic oscillator, Zeeman effect, Stark effect.

UNIT-3: TIME DEPENDENT PERTURBATION THEORY (PERIODS-12 Hours)

Time dependent perturbation theory: First order perturbation, harmonic perturbation, transition to continuum states, absorption and emission of radiation, Einstein's coefficients, Fermi's golden rule.

UNIT-4: VARIATION METHOD (PERIODS-08 Hours)

Variational method: Basic principles and applications to particle in box, simple harmonic oscillator, hydrogen atom.

UNIT-5: WKB APPROXIMATION (PERIODS-10 Hours)

WKB approximation: Qualitative development and condition for validity of this approximation, Bohr's quantization condition, applications to tunnelling such as α-particle field emission.

References:

1.) Quantum Mechanics: B. H. Bransden and C. J. Joachain, 2nd Edition, 2004,

Pearson Education ltd.

2.) Quantum Mechanics: L. I. Schiff, 3rd edition, 1998, MGH book company.

3.) Quantum Mechanics: J. D. Powell and B. Crossman. 1st edition, 1998, Narosa

Publishing House.

4.) Quantum Mechanics: S. Gasiorowicz, 3rd edition, 2003, Wiley International.

MS/ES-202: EXPERIMENTAL TECHNIQUES AND DATA ANALYSIS

UNIT 1: MEASUREMENT, INTERPRETATION AND ANALYSIS: (PERIODS-10 Hours)

Basic definitions, Accuracy and precision, significant figures, types of errors: gross errors, systematic errors, random errors, statistical analysis: arithmetic mean, deviation from the mean, average deviation, standard deviation, probability of errors: Normal distribution of errors, probable errors, propagation of errors

UNIT 2: CURVE FITTING, CUBIC SPLINES AND APPROXIMATIONS

(PERIODS-10 Hours)

Introduction, least square fitting procedures: Fitting a straight line, Non-linear curve fitting, Curve fitting by a sum of exponentials; Data fitting with cubic splines: derivation of the governing equations, end conditions, minimizing property of cubic splines; Approximation of functions: Chebyshev polynomials, Economizing of power series, chisquare test

UNIT 3: TRANSDUCERS: (PERIODS-10 Hours)

Classification of transducers, selecting a transducer. Working principle and characteristics of the main transducers for measurement of: Temperature, pressure, vacuum.

UNIT 4: SIGNAL CONDITIONING: PROCESSES (PERIODS-09 Hours)

Input/output impedance, Impedance matching, Amplification: the Differential amplifier, Instrumentation amplifiers, Modulation techniques: Amplitude modulation, Frequency modulation, phase modulation,

UNIT 5: SIGNAL CONDITIONING: RECOVERY AND CONVERSION

(PERIODS-09 Hours)

Demodulation, Filters, Noise reduction, Lock-in-amplifiers, phase locked loop, Box car integrators, Fourier transforms, sample and hold unit, ADC: quantization, resolution, sampling frequency

Reference Books:

1. Modern Electronic And Measurement Techniques-A.D.Helfrick,W.D.Kooper

1st Edition,2004, Prentice Hall Of India Pvt. Ltd.

2. Instrumentation: Devices And Systems- Rangan, Mani, Sharma

1st Edition,1990, Tata McGraw Hill Publication Pvt. Ltd.

3. Introductory Methods Of Numerical Analysis- S.S.Sastri

2nd Edition, 1992, Prentice Hall Of India Pvt. Ltd

4. Introduction To Instrumentation And Control- A.K.Ghosh

1st Edition, 2000, Prentice Hall Of India Pvt. Ltd

MS/ES-203: STATISTICAL MECHANICS

UNIT 1: LAWS OF THERMODYNAMICS (PERIODS-08 HOURS)

Necessity of Statistical Mechanics The laws of thermodynamics and their consequences, the problem of kinetic theory: phase space, Gibbsian ensembles, Maxwell's relations and thermodynamic functions. Statistical description of system of particles: state of a system, microstates, ensembles, basic postulates.

UNIT 2: STATISTICAL DESCRIPTION OF SYSTEM OF PARTICLES & STATISTICAL

THERMODYNAMICS (PERIODS-10 Hours)

Behaviour of density of states, density of states for ideal gas in classical limit, thermal and mechanical interactions, quasi-static process Statistical thermodynamics: Irreversibility and attainment of equilibrium, Reversible and irreversible processes, thermal interaction between macroscopic systems, approach to thermal equilibrium, dependence of DoS on external parameters, Statistical calculation of thermodynamic variables.

UNIT 3: CLASSICAL STATISTICAL MECHANICS (PERIODS-10 Hours)

Microcanonical ensemble and their equivalence, canonical and grand canonical ensembles, partition function, thermodynamic variables in terms of partition and grand partition functions, ideal gas, Gibbs paradox, validity of classical approximation, equipartition theorem, MB gas velocity and speed distribution, Chemical potential, Free energy and connection with thermodynamic variables, 1st and 2nd order phase transition, phase equillibria.

UNIT 4: FORMULATION OF QUANTUM STATISTICS (PERIODS-10 HOURS)

Formulation of quantum statistics, ensembles in quantum statistical mechanics, The theory of simple gases: Maxwell Boltzmann, Bose-Einstein, Fermi-Dirac gases, Statistics of occupation numbers, Evaluation of partition functions, Ideal gases in the classical limit

UNIT 5: IDEAL BOSE AND FERMI SYSTEMS (PERIODS-10 HOURS)

Ideal Bose system: Thermodynamic behaviour of an ideal Bose gas, Bose-Einstein condensation Thermodynamics of Black-body radiation, Stefan-Boltzmann law, Wien's displacement law, Specific heat of solids (Einstein and Debye models) Ideal Fermi systems: Thermodynamic behaviour of an ideal Fermi gas, degenerate Fermi gas, Fermi Energy and mean energy, Fermi Temperature, Fermi velocity of a particle of a degenerate gas

Reference Books:

1. Fundamentals Of Statistical And Thermal Physics- F.Reif

1st Edition, 1965, McGraw Hill Publication Pvt. Ltd.

2. Statistical Mechanics- K. Huang

1st Edition, 1991, Wiley Eastern Ltd.

3. Statistical Mechanics-R.K. Patharia

2nd Edition, Elsevier

4. Fundamentals Of Statistical Mecanics-B.B.Laud

Edition, 2007,New Age International Publishers.

5. Statistical Physics – F.Reif.

Berkeley Physics Course(Vol.5), Tata McGraw Hill Pvt. Ltd.

MS/ES- 204: ELECTROMAGNETIC THEORY

UNIT-1: ELECTROSTATICS (PERIODS-5Hours)

Coulomb's law, the electric field, continuous charge distribution, divergence and curl of electrostatic fields, Gauss's law and applications, electric potentials, Poison's equations and Laplace equation, the potential of localized charge distribution, electrostatic boundary condition, work and energy in electrostatics.

UNIT-2: MAGNETOSTATICS (PERIODS-5 Hours)

Biot-savarts laws, divergence and curls of B, Amperes law and its applications, magnetic vectors potential

UNIT-3: ELECTRODYNAMICS (PERIODS-10 Hours)

Electromotive force, electromagnetic induction, energy in magnetic fields, Maxwell's equation's, Maxwell's equations in matter, boundary conditions, conservation laws, the continuity equation and Poyntings theorem.

UNIT-4: ELECTROMASGNETIC WAVES (PERIODS-12 Hours)

Boundary conditions, reflection and transmission, polarization, electromagnetic waves in vacuum, wave equations for E and B, monochromatic plane waves, energy and momentum in electromagnetic waves, electromagnetic waves in matter, propagation in linear media, R and T at normal incidence, absorption and dispersion, electromagnetic waves in conductors, reflection at conducting surface, guided waves, wave guides, TE waves in rectangular waveguides, the co-axial transmission line.

UNIT-5: POTENTIAL FIELDS (PERIODS-9 Hours)

The potential formulation, scalar and vector potentials, gauge transformations, Coulomb and Lorentz's gauge, continuous distribution retarded potentials, point charges, Lienard-Wiechert potential, field of moving point charge.

UNIT-6: RADATION (PERIODS-7 Hours)

Dipole radiation, electric dipole radiation and magnetic dipole radiations, power radiated by a point chare.

Reference Books.

1. Introduction To Electrodynamics- D.J. Griffith

3rd Edition, 2000, Prentice Hall Of India.

2. Electromagnetic Field Theory Fundamentals- Guru And Hiziroglu

2nd Edition , 1998, Cambridge University Press.

3. Introduction To Electromagnetic Fields-Paul And Nasar.

2nd Edition, 1987, McGraw Hill Company Pvt. Ltd.

4. Classical Electrodynamics- J.D.Jackson

3rd Edition,2007,Wiley India Pvt Ltd

5. Electricity And Magnetism- Edward Purcell(For Basic Readings)

2nd Edition, Tata McGraw Hill Publication Pvt. Ltd

6. Fundamentals Of Applied Electromagnetics- Fawwaz Ulaby

1st Edition, 2002, Prentice Hall Of India Pvt. Ltd.