

APPROVED SYLLABUS
For
MASTERS PROGRAMME (M.Sc.)
In
PHYSICS
(BATCH 2016 AND ONWARDS)
Under
CHOICE BASED CREDIT SYSTEM
(CBCS)



**ISLAMIC UNIVERSITY OF
SCIENCE AND TECHNOLOGY**

DEPARTMENT OF PHYSICS
ISLAMIC UNIVERSITY OF SCIENCE AND TECHNOLOGY,
AWANTIPORA, PULWAMA-192 122

Approved in the first Board of Studies (BoS) meeting held on 12-01-2017

MASTER COPY

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DEPARTMENT OF PHYSICS
ISLAMIC UNIVERSITY OF SCIENCE AND TECHNOLOGY,
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- **CC- Core Course**
- **DCE- Discipline Centric Elective Course**
- **OE- Open Elective Course**

SEMESTER I

Course Type	Course Code	Course Title	Credit Distribution				Marks Distribution			Total Credits
			L	P	T	Total	Int.	Ext.	Total	
Core Course (CC)	PHY-CC-101	Mathematical Methods in Physics I	3	0	2	04	30 + 20	50	100	20
Core Course (CC)	PHY-CC-102	Quantum Mechanics I	3	0	2	04	30 + 20	50	100	
Core Course (CC)	PHY-CC-103	Lab I	0	4	0	04	30 + 20	50	100	
Discipline Elective Course (DCE)	PHY-DCE-101	Classical Mechanics	3	0	2	04	30 + 20	50	100	
Discipline Elective Course (DCE)	PHY-DCE-102	Electronics	3	0	2	04	30 + 20	50	100	
Discipline Elective Course (DCE)	PHY-DCE-103	Computational Physics	3	0	2	04	30 + 20	50	100	

Open Elective Course (Offered by Department of Physics for other Departments of the University)

Course Type	Course Code	Course Title	Credit Distribution				Marks Distribution			Total Credits
			L	P	T	Total	Int.	Ext.	Total	
Open Elective Course	PHY-OE-101	Physics and Technology	2	0	0	2	15+10	25	50	2

SEMESTER II

Course Type	Course Code	Course Title	Credit Distribution				Marks Distribution			Total Credits
			L	P	T	Total	Int.	Ext.	Total	
Core Course (CC)	PHY-CC-201	Classical Electrodynamics	3	0	2	04	30 + 20	50	100	20
Core Course (CC)	PHY-CC-202	Statistical Physics	3	0	2	04	30 + 20	50	100	
Core Course (CC)	PHY-CC-203	Lab II	0	4	0	04	30 + 20	50	100	
Discipline Elective Course (DCE)	PHY-DCE-201	Quantum Mechanics II	2	0	2	03	30 + 20	50	100	
Discipline Elective Course (DCE)	PHY-DCE-202	Mathematical Methods in Physics II	2	0	2	03	30 + 20	50	100	
Discipline Elective Course (DCE)	PHY-DCE-203	Optics	2	0	2	03	30 + 20	50	100	
Open Elective Course (OE)		Chosen from the list of Open Elective Courses offered by other departments in the University	2	0	0	02	15+10	25	50	

Open Elective Course (Offered by Department of Physics for other Departments of the University)

Course Type	Course Code	Course Title	Credit Distribution				Marks Distribution			Total Credits
			L	P	T	Total	Int.	Ext.	Total	
Open Elective Course	PHY-OE-201	Philosophical foundations of Physics	2	0	0	2	15+10	25	50	2

Total credit and marks distribution for first two Semesters

Course Type	Papers	Credits per paper	Total credits	Marks per paper	Total Marks
Core Course (Theory)	04	04	16	100	600
Core Practical	02	04	08	100	200
DCE	04	04, 03	14	100	200
OE	01	02	02	50	50
	11		40		

SEMESTER

I

PHY-CC- 101-Mathematical Methods in Physics

Credits: 04
L 3 P 0 T 2

UNIT I

Lectures 16

Vector analysis: The gradient, divergence and Gauss's theorem curl of a vector field and Stoke's theorem, Orthogonal curvilinear coordinates, tangent and normal vectors, Gradient, Curl, divergence and Laplacian in spherical and cylindrical polar co-ordinates.

Matrices: Vector Spaces, Linear dependence and independence, Bases, dimensionality, linear transformations, inverse of matrices, similarity transformations, System of linear equations (Particular cases and General), The Eigen value problems.

UNIT II

Lectures 16

Complex Analysis: Functions of a complex variable, Analytic functions, Cauchy-Riemann relations, Conjugate and harmonic nature of the real and imaginary parts of an analytic function, Cauchy's theorem, Cauchy's integral formula, Taylor and Laurent expansions, classification of singularities, The Point at Infinity; Calculus of Residues, Residues at Infinity, residue theorem, Evaluation of definite integrals using Cauchy's residues.

UNIT III

Lectures 16

Differential equations: Partial Differential Equations, Classes and Characteristics, Boundary Conditions, First-order, Separable variables, Solution of linear first-order ODEs, Regular and irregular singular points of a second order ordinary differential equation. Series solutions– Frobenius method. Series solution of Bessel, Laguerre, Hermite and Legendre differential equations, Second Solution, The gamma and beta function. Definition and properties.

UNIT IV

Lectures 16

Special Functions: Bessel Functions of First kind, Orthogonality, Neuman Functions, Henkel Functions, Modified Bessel Functions, Spherical Bessel Function; Legendre Function, Orthogonality, Associated Legendre Function, Spherical Harmonics, Hermite Functions; Laguerre Functions, generating functions, Recurrence relations, Rodrigue's formula for all functions

Suggested References

1. Mathematical Methods for Physicists by G. B. Arfken and H. J. Weber, Academic Press.
2. Mathematical Methods For Students of Physics and Related Fields, Sadri Hassani, Springer 2009.
3. Advanced Engineering Mathematics by Michel D, Greenberg
4. Mathematical Methods for Physics and Engineering (3rd Ed.), Riley, Hobson and Bence, Cambridge
5. Advanced Engineering Mathematics, E Kreyzig (8th Ed.), Wiley
6. Mathematical physics by M L Boas, Wiley publishers

UNIT I

Lectures 16

Review: Inadequacy of classical Physics, wave particle duality, wave packets and uncertainty relations, probabilistic interpretation, Wavefunctions, probability densities, probability current, Expectation values, Ehrenfest theorem.

Postulates of quantum mechanics: Representation of states, Eigen functions and Eigen values, Physical interpretation of eigen values, eigen functions, degeneracy, completeness and closure properties, orthogonality of eigen functions, eigen values and eigen functions of momentum operator

Schrodinger equation, one dimensional potential problems, Particle in a box, Potential Step, Potential barriers, Tunnelling.

UNIT II

Lectures 16

General formalism of Quantum Mechanics

Linear harmonic oscillator (1D) by Analytic method, Eigen values and eigen functions of simple harmonic oscillator by operator method, Dirac delta function.

Linear vector spaces, elements of Hilbert space, Dirac's bra-ket notation, dynamical variables and linear operators, self-adjoint operators, projection operators, unit operator, Hermitian and Anti-Hermitian and unitary operators, change of basis, unitary transformation, Matrix representation of an operator, Commutation relations for Position and Momentum Operator.

Time development of a quantum mechanical system, Schrödinger, Heisenberg and interaction pictures, Heisenberg's equation of motion.

UNIT III

Lectures 16

Angular Momentum:

Angular Momentum- Orbital, Spin and total angular momentum operators. Eigen values and eigen functions of L^2 and L_z operators, ladder operators L_+ and L_- , Pauli spin matrices, their Commutation relations, angular momentum as a generator of infinitesimal rotations, matrix representation of J in $|j, m\rangle$ basis. Addition of angular momenta, Computation of Clebsch-Gordon coefficients in simple cases, Hydrogen atom, Stern-Gerlach experiment.

UNIT IV

Lectures 16

Identical Particles

Many particle systems, systems of identical particles, ex-change degeneracy, symmetrization postulate, construction of symmetric and anti-symmetric wave functions from unsymmetrized functions. The Pauli Exclusion Principle and spin statistics connection, spin angular momentum, Collision of identical particles, electron spin functions, density operator and density matrix.

Suggested References

1. Quantum Mechanics by L. I. Schiff, McGraw Hill, 2014.
2. Principles of Quantum Mechanics by R. Shankar, Springer, 1994.
3. Introductory Quantum Mechanics, R. L. Liboff, Pearson, 2002.
4. Introduction to Quantum Mechanics by David J.Griffiths, Pearson, 2005
5. Quantum Mechanics by L.D. Landau and E. M. Lifshitz, Elsevier, 2005.
6. Quantum Mechanics Concepts and Applications by N. Zettili, Wiley, 2009.

PHY-CC-103-LAB I

**Credits: 04
L O P 4 T 0**

The list for experiments is as given below. The students will have to perform at least 08 experiments out of following 14 experiments:

1. To study the characteristics and dead time of a G.M. Counter.
2. Hall Effect
Determination of Hall Voltage and RH
Determination of mobility of charge carriers and carrier concentration
3. To determine the Wavelength of laser by Fresnel Biprism
4. To determine the band gap of semiconductor from temperature dependence of resistivity using Four Probe Method
5. To determine e/m by Thomson/Helical Method
6. To study Meissner Effect
7. Experiments with Phoenix kit
8. To determine Plank's Constant (Photo Cell method)
9. Michelson Interferometer
10. To study Attenuation coefficient of gamma rays using GM Counter
11. Study of Lissajous Figures
12. To design and study the characteristics of BJT
13. To design and study the characteristics of FET
14. To design and study of Operational amplifier (IC-741): summer, inverting/non-inverting amplifier.

UNIT I

Lectures 16

Review of Mechanics of a system of particles; Conservation laws, The Lagrangian Formalism- Constraints and their classifications, Generalized coordinates, Virtual displacement, D'Alembert's principle and Lagrangian equations of motion with few examples.

Variational Principles and Lagrange's Equations: Hamilton's Principle, Calculus of variations, Derivation of Lagrange's equations from Hamilton's Principle; symmetry properties of space and time and conservation theorems.

Force field- Two-body central force problem, Kepler's problem and scattering by a central field. Rutherford scattering, Virial Theorem, Exercises.

UNIT II

Lectures 16

Hamilton's Canonical equations of motion, Examples, the simple harmonic oscillator, Hamiltonian for a free particle in different coordinates, Hamiltonian for electromagnetic force, coupled oscillators. Cyclic coordinates and conservation theorems. Statement of Noether's Theorem. Physical significance of the Hamiltonian function. Derivation of Hamilton's equations from variational Principle and Lagrange's equations.

UNIT III

Lectures 16

Equations of canonical transformations, properties and generating functions of four special type of canonical transformations examples of Canonical transformations, Poisson brackets (PB), properties of Poisson brackets, angular momentum and Poisson bracket relations. Equation of motion in the Poisson bracket notation. Invariance of P.B. under canonical transformations.

The Hamilton-Jacobi equation, example of the harmonic oscillator treated by the Hamilton-Jacobi method. Liouville's theorem.

UNIT IV

Lectures 16

Review of Mechanics of rigid bodies; Euler equations of motion for a rigid body. Torque free motion of a rigid body. Euler angles, angular velocity of a rigid body. Precession of systems of charges in a magnetic field. Small Oscillations: General formalism, Eigen-value equation, normal coordinates and normal modes.

Special theory of Relativity: Introduction and postulates, Lorentz Transformation, Length Contraction, Time Dilation, Twin Paradox, four vectors, relativistic kinematics and mass energy equivalence.

Suggested References:

1. Classical Mechanics by H. Goldstein, Charles P. Poole, John Safko, Pearson, 2011.
2. An introduction to Mechanics, D. Kleppner and R. Kolenkow, Tata McGraw-Hill, 1973.
3. Classical Mechanics by N.C. Rana and P.S. Joag, Tata McGraw-Hill, 1991.
4. Classical Mechanics by S. N. Biswas, Books and Allied Pvt. Ltd, 1998.
5. Classical Mechanics by J. C. Upadhaya, Himalaya Publishing House, Mumbai. 2006.
6. Classical Dynamics of particles and systems by S. T. Thornton and J. B. Marion, Cengage Learning, 2008.

PHY-DCE-102-Electronics

Credits: 04
L 3 P 0 T 2

UNIT I

Lectures 16

Semiconducting Materials, conduction in semi-conductors, equilibrium charge carrier concentrations in intrinsic semiconductors and extrinsic semiconductors, Fermi energy in intrinsic and extrinsic semiconductors, diode built in voltage, junction capacitance, PN junction diode, diode equation, zener diodes, Zener and avalanche breakdowns, tunnel diode, LED, varactor diode, Schottky barrier, Laser diode, Photodiodes and Solar cell. High frequency devices: Gunn diode, IMPATT diode.

UNIT II

Lectures 16

Fundamentals of operation of UJT and BJT, Analysis of CE amplifier using h-parameters, The T-network equivalent circuit, constants of CB and CE amplifier using emitter, base, collector resistance, Biasing technique to BJT, stabilization factor, temperature stabilization, operating point, fixed bias, emitter feedback bias, voltage feedback bias. Field Effect Transistors (FET) and MOS-FET: Structure, Working, Derivations of the equations for I-V characteristics under different conditions.

UNIT III

Lectures 16

Feedback Principle, Negative feedback, effect of negative feedback on input/output resistances, voltage gain, gain stabilization, band width, Oscillators: Oscillator operation, Phase shift Oscillator, Wien-bridge Oscillator, Hartley Oscillator. Block diagram of an operational amplifier – Characteristics of an ideal operational amplifier, Differential amplifier: voltage gain. Applications of op-amp, summing amplifier– inverting and non-inverting configurations, subtractor, difference summing amplifier, Integrator. Instrumentation amplifier.

UNIT IV

Lectures 16

Number Systems, Boolean Algebra, Karnaugh map, Combinational Circuits like Adder, Subtractor, Encoder /Decoder, Mux/Demux, Comparators, Sequential Circuits like Flip Flops, Registers, Counters, ADC and DAC. Microprocessor and microcontroller (basics)

Suggested References

1. Electronic Fundamentals and Applications by J. D. Ryder, PHI, 1976.
2. Digital Principles and Applications by D. P. Leach, A. P. Malvino and G. Saha, McGraw Hill, 1995.
3. Op-Amps and Linear Integrated Circuits by R. A. Gayakward, 2000.
4. Integrated Electronics by J. Millman and C. C. Halkias, Tata McGraw Hill, 2001.
5. Electronic Devices and Circuit Theory by R. L. Boylestad and L. Nashelsky, Pearson, 2006.
6. Solid State Electronic Devices by B. G. Streetman and S. K. Banerjee, PHI, 2014.

Unit I

Stochastic Processes:

Lectures 16

Theory of random walks and simulation of random walks in one, two and three dimensions. Elementary idea sand simulations of self-avoiding walks, additive and multiplicative stochastic processes, Brownian motion and fractional Brownian motion.

Unit II

Lectures 16

Percolation theory:

Percolation theory and simulation by Hoshen-Kopelman algorithm; Application to simple lattice models in Physics.

Unit III

Lectures 16

Simulations of physical models:

Elementary ideas of: (a) Time-average and Molecular dynamics; Dynamical equations and physical potentials; Verlet algorithm (b) Ensemble average and Monte Carlo methods; Metropolis algorithm.

Introduction to the simulations of: (a) Ising model in magnetism (b) Bak-Tang-Wiesenfeld model in studies of self-organized criticality.

Unit IV

Lectures 16

Combinatorial optimization problems:

Classification of problems; examples of optimization problems: traveling salesman problem (TSP) and satisfiability (k-SAT) problem; heuristic methods of solutions and simulated annealing technique.

Suggested References

1. Introduction to Percolation Theory by D. Stauffer and A. Aharony, Taylor and Francis, 1985.
2. Numerical recipes in C: The Art of Scientific Computing by W. T. Vetterling, S. A. Teukolsky W. H. Press and B. P. Flannery, Cambridge University Press, 1988.
3. Understanding Molecular Simulation by D. Frenkel & B. Smit, Academic Press, 2001.
4. Equilibrium Statistical Physics by M. Plischke and B. Bergersen, world Scientific, 2006.

PHY-OE-101 Physics and Technology

Credits: 02

L 2 P 0

UNIT I

Lectures 16

Industrial physics, Electrons at work, long distance telephony, vacuum tubes.

Manhattan Project and its spinoff.

Nuclear energy, Nuclear fission, Nuclear fusion and Nuclear reactors.

Plasma Physics and ITER.

Semiconductor technology.

Super conductivity, SQUID, Super conducting particle accelerators.

UNIT II

Lectures 16

Transistor and microwave technology, the laser, quantum optics, optical fibres, idea of quantum computer, Technology development at CERN. Nanotechnology, Novel materials, Particle accelerators.

References:

1. Plasma Physics and Controlled Fusion by F. F. Chen, Plenum Press, 1974.
2. Radiation Detection and Measurement by G. F. Knoll, John Wiley and Sons, 1980.
3. Introduction to Nanotechnology by Charles P. Poole, Jr. And Frank J. Owens, John Wiley and Sons, 2003.
4. Superconductivity by C. P. Poole, Jr., H. A. Farach, R.J. Creswick and R. Prozorov, Elsevier, 2007.

SEMESTER

II

UNIT I

Lectures 16

Electrostatics

Coulomb's law, Electric field, Gauss's law, applications of Gauss's law, Electric Potential, Poisson's equation and Laplace's equation, Work and energy in electrostatics

Techniques for calculating potentials: Laplace's equation in one, two and three dimensions, boundary conditions and uniqueness theorems, Simple boundary value problems using Green's functions, the method of images, separation of variables etc, Multipole expansion.

UNIT II

Lectures 16

Magnetostatics and Electrodynamics

Biot-Savart Law, Ampere's law and applications of Ampere's law, Magnetic vector potential, Magnetostatic fields in Matter: Magnetization, field of a magnetized object, magnetic field inside matter, linear and non linear magnetic media

Time dependent fields, Faraday's law, Maxwell's displacement current, Differential and integral forms of Maxwell's equations.

Scalar and vector potentials, gauge transformations, Coulomb and Lorentz Gauge, Maxwell's equations in terms of potentials. Energy and momentum in electrodynamics.

UNIT III

Lectures 16

Electromagnetic waves and Radiations

Electromagnetic waves in non conducting media, Monochromatic plane waves in vacuum, propagation through linear media, Boundary conditions, Reflection and transmission at interfaces. Fresnel's laws, Electromagnetic waves in conductors, Modified wave equation, monochromatic plane waves in conducting media, Dispersion in non conductors, free electrons in conductors and plasmas, Transmission lines and wave guides.

Radiation from a point charge, Lienard-Wiechart potentials, fields of a point charge in motion, power radiated by a point charge.

Retarded potentials, Electric dipole radiation, magnetic dipole radiation.

UNIT IV

Lectures 16

Electrodynamics and Relativity

Review of special theory of relativity, Lorentz transformations, Minkowski four vectors, energy-momentum four vector, covariant formulation of mechanics Transformation of electric and magnetic fields under Lorentz transformations, field tensor, invariants of electromagnetic field, Covariant formulation of electrodynamics, Lorentz force on a relativistic charged particle.

Suggested References

1. Classical Electrodynamics by J. D. Jackson, John Wiley and Sons, 1962.
2. Electricity and Magnetism by E. M. Purcell, McGraw Hill, Berkeley Series Vol. II, 1985.
3. Classical Electrodynamics by W. Greiner, Springer, 1991.
4. Introduction to electrodynamics by D. J. Griffiths, Pearson, 1999.
5. Introduction to Electrodynamics by A. Z. Capri and P. V. Panat, Narosa, 2002.
6. Electrodynamics of Continuous Media by L. D. Landau, E. M. Lifshitz and L.P. Pitaevskii, Elsevier, 2005.

UNIT I

Statistical basis of thermodynamics

Lectures 16

State of a system and state functions, macro and microstates, ensemble, basic postulates, phase space, Liouville's theorem, trajectories and density of states, density of state for ideal gas in classical limit, quasi-static process.

Irreversibility and attainment of equilibrium, Reversible and irreversible processes, The principle of maximum entropy, classical ideal gas, entropy of mixing and Gibb's paradox. Statistical calculation of thermodynamic variables.

UNIT II

Classical ensemble theory

Lectures 16

Microcanonical ensembles and their equivalence, Canonical and grand canonical ensembles, partition function, thermodynamic variables in terms of partition function and grand partition function, ideal gas, validity of classical approximation, equipartition theorem and Virial theorem, Maxwell-Boltzmann gas velocity and speed distribution. Chemical potential, Free energy and connection with thermodynamic variables

UNIT III

Quantum Statistical Mechanics

Lectures 16

The postulates of quantum statistical mechanics. Symmetry of wave functions, The Liouville theorem in quantum statistical mechanics, condition for statistical equilibrium, Ensembles in quantum mechanics,

The quantum distribution functions (BE and FD), the Boltzmann limit of Boson and Fermion gases, the derivation of the corresponding distribution functions.

Ideal Fermi gas, application of Fermi-Dirac statistics to the theory of free electrons in metals, degeneracy and magnetic susceptibility, Ideal Bose gas, Application of Bose statistics to the photon gas, principle of detailed balance, Thermodynamics of Black body radiation, derivation of Planck's law, Bose-Einstein condensation.

UNIT IV

Phase Transitions

Lectures 16

First and Second order phase transition; phase equilibria, Diamagnetism, paramagnetism, and ferromagnetism, Ising Model, Landau theory of phase transition; first and second order transitions, Landau free energy for Random walk and diffusion equation, Brownian motion.

Suggested References

1. Statistical Mechanics by R.K. Pathria and P. D. Beale, Elsevier, 1988.
2. Statistical Physics by F. Reif, McGraw Hill, Berkeley series, Vol. 5, 1967.
3. Statistical Physics Part 1 and 2 by L. D. Landau and E. M. Lifshitz, Elsevier, 1980.
4. Statistical Mechanics by R.P. Feynman, Westview Press, 1997.
5. Statistical Mechanics by K. Huang, John Wiley & Sons, 2000.
6. Introduction to Thermodynamics and Statistical Mechanics by K. Stowe, Cambridge, 2007.

PHY-CC-203-LAB II

Credits: 04
L O P 4 T 0

The list of experiments is as given below. The students will have to perform at least 08 experiments out of following 14 experiments:

1. Electron Spin Resonance (ESR)
2. To study the characteristics of a PN junction with varying temperature and to find the energy band gap of semiconductor.
To measure the capacitance of the junction
3. To Study of Hysteresis loop of Magnetic Materials
4. To study Poisson and Gaussian distributions using a GM counter
5. Study of Operational amplifier (IC-741): Integrator and differentiator
6. Study of optical fiber
7. Studying RC filters Active and Passive
8. Experiments with Phoenix kit
9. Frank-Hertz experiment
10. Study of regulated and stabilized power supply
11. To determine Stefan's Constant
12. Study of Solar Cell
13. To determine magnetic susceptibility of a paramagnetic material using Quinck's tube.
14. Study of ionizing radiations and characteristics of photomultiplier tube using Scintillation Counter.

UNIT I

Lectures 16

Approximation methods for stationary Systems

Time independent perturbation theory, Time independent perturbation theory for a non degenerate energy level, time independent perturbation theory for a degenerate energy level, Applications: one dimensional harmonic oscillator subjected to a perturbing potential in x , x^2 and x^3

Variational Method, Applications, ground state of Helium

WKB approximation, the classical region, connection formulae, tunnelling.

Time dependent perturbation theory; Statement of the problem, approximate solution of the Schrodinger equation, constant perturbation, harmonic perturbation, transition to a continuum, transition probability, the Fermi golden rule, adiabatic and sudden approximations.

UNIT II

Lectures 16

Scattering theory

The scattering experiment, relationship of the scattering cross section to the wave function, scattering amplitude and scattering cross-section, Born approximation, scattering by a spherically symmetric potential, cross-section for scattering in a screened coulomb potential, validity of Born's approximation.

Method of partial waves, Expansion of a plane wave in terms of partial waves, scattering by a central potential, optical theorem.

UNIT III

Lectures 16

Relativistic Quantum Mechanics

Klein-Gordon equation, Dirac equation and its plane wave solution, significance of negative energy solutions, spin angular momentum of the Dirac particle, non-relativistic limit of Dirac equation. Electron in electromagnetic fields, spin magnetic moment. spin-orbit interaction, Dirac equation for a particle in a central field. Fine structure of hydrogen atom, Lamb shift.

Suggested References

1. Quantum Mechanics by L. I. Schiff, McGraw Hill, 2014.
2. Principles of Quantum Mechanics by R. Shankar, Springer, 1994.
3. Introductory Quantum Mechanics, R. L. Liboff, Pearson, 2002.
4. Introduction to Quantum Mechanics by David J. Griffiths, Pearson, 2005
5. Quantum Mechanics (Non-Relativistic) by L.D. Landau and E. M. Lifshitz, Elsevier, 2005.
6. Quantum Mechanics Concepts and Applications by N. Zettili, Wiley, 2009.
7. Modern Quantum Mechanics by J. J. Sakurari and J. J. Napolitano, Pearson, 2011.
8. Quantum Field Theory by F. Mandl and G. Shaw, John Wiley & Sons, 1984.

PHY-DCE-202-Mathematical Methods in Physics II

**Credits: 03
L 2 P 0 T 2**

UNIT I

Lectures 16

Fourier series and Integral Transforms

Fourier Series: Definition, Properties, Convergence, Application of Fourier series, Fourier Integral and Fourier transform and inverse Fourier transform, Convolution theorem, Parseval's theorem, Laplace transform and its properties, inverse Laplace transforms, solution of differential equations using Laplace transforms, Fourier transform & Laplace transform of distributions

UNIT II

Lectures 16

Green's Functions

Green's Functions in One Dimension: Calculation of Green's Functions for simple differential operators, Green's Functions for Second order Linear Differential Operators (SOLDOs), Self Adjoint SOLDOs, Generalized Green's identity. Multidimensional Green's Functions: Second-Order PDEs in m Dimensions, Multidimensional GFs and Delta Functions, Spherical Coordinates in m Dimensions, Green's Function for the Laplacian. Fourier Series, Properties and Applications.

UNIT III

Lectures 16

Numerical Methods

The solution of Numerical algebraic and transcendental equations: Direct methods and Iterative methods, Bisection Method, Secant Method, False- position, Newton – Raphson method, the method of successive approximations, convergence of solutions.

Solutions of system of linear equations, Direct methods: Gauss elimination Method, Gauss – Jordan elimination method, Matrix inversion. Iterative methods: Jacobi Iteration method, Gauss- Seidel method. Newton's forward and backward formulas to get derivatives, Numerical Integration: Newton – Cotes formulae, Trapezoidal, Simpson 1/3 and 3/8 rule and Weddle's rule. Solution of first and second order differential equation by Runge Kutta method.

Suggested References

1. Mathematical Methods for Physicists (7th Ed.), G. B. Arfken and H. J. Weber, Academic Press
2. Mathematical Methods For Students of Physics and Related Fields, Sadri Hassani, Springer (2009)
3. Advanced Engineering Mathematics by Michel D, Greenberg
4. Sastry, S. S., *Introductory Methods of Numerical Analysis*, 3rd ed., Prentice Hall India, 1998.
5. Scarborough, James B., *Numerical Mathematical Analysis*, Oxford and IBH publishing co.
6. William H. Press, Saul A. Teukolsky, William T. Vetterling, Brain P. Flannery
7. Numerical Recipes: The Art of Scientific Computing Third Edition (Canbrisse, 2007)
8. Atkinson, K. E., *An Introduction to Numerical Analysis*, John Wiley and Sons.
9. Balaguruswamy, E., *Numerical Methods*, Tata McGraw Hill.

UNIT I

Lectures 16

Propagation of light in optical media:

Dispersion, dispersion in dilute and dense gases, group and signal velocities. Structure of a plane electromagnetic wave in an anisotropic medium. Wave surface, normal surface and ray surface. Dielectric tensor. Equation to the normal surface Fresnel equation of wave normals. Light propagation in uniaxial and biaxial crystals. double refraction, polarizing prisms. Jones vector, circular, elliptic states of polarization, Malu's law, Jones matrices and linear optical devices, phase retarders, quarter and half wave plates, Stokes parameters.

UNIT II

Lectures 16

Wave optics

Interference: Planar wave description of light, two-beam interference, Michelson interferometer, Multi-beam interference, Fabry-Perot interferometer.

Diffraction: Kirchoff's diffraction theory, regimes of diffraction, Fresnel and Fraunhofer diffraction, Integral theorem of Helmholtz and Kirchoff, rectangular slit, circular aperture, single and multiple slit diffraction.

UNIT III

Lectures 16

Non-linear Optics:

Interaction of radiation with a dielectric medium, dielectric Susceptibility, Kerr effect, Harmonic generation, Second and third harmonic generation,

Phase matching criterion, coherence length for second harmonic radiation, optical mixing, self focussing of light, parametric generation of light.

Fibre Optics: Optical Fibre, Structure and basic theory, Coherent Bundle- Numerical Aperture Single and Multimode Fibres- Pulse Dispersion –Waveguide Dispersion-Dispersion Compensating fibres, light propagation in optical fibres.

Suggested References

1. Introduction to Modern Optics by G. R. Fowles, Dover Pub., 1968.
2. Lasers and Non-Linear Optics by B. B. Laud, New Age Pub., 1985.
3. Optical Electronics by A. Ghatak and K. Thyagarajan, Cambridge Univ. Press, 1989.
4. Optics by E. Hecht and A. R. Ganesan, Pearson, 2002.
5. Optics Principles and Applications by K. K. Sharma, Academic Press, 2006.

UNIT-I

Lectures 16

Classical Logic: Plato, Aristotle and Chrysippus

Classical philosophy of knowledge: Francis Bacon and Experience, Descartes and Reason, Locke and Empiricism, Hume's Pragmatism, Kant

Classical Physics and Determinism: Measurement: defining the object, subjectivity, Aristotelian space-time, Newtonian mechanics and space-time, The Leibnitz-Clarke Debate, Space as metaphor, Concept of Ether, Unification of Electricity and Magnetism: Maxwell's equations.

Special Relativity: Simultaneity and Relativity of time, Unification of Space and time (Four dimensional space-time), Twin paradox, Entropy and Eschatology, Light cone, time as metaphor, unification of mass and energy ($E=mc^2$), General Theory of Relativity, Curved Spaces.

UNIT-II

Lectures 16

The Epistemology of Physics: Concept of Matter, Failure of Classical Physics, Probabilistic interpretation of Quantum Mechanics, why interpretation? Quantum Dialect, The logic of Quantum world, uncertainties, Born interpretation, Copenhagen interpretation : Reduction of wave function, Principle of Complementarity, Heisenberg matrix formulation, Schrodinger wave interpretation, Incompleteness of Quantum Mechanics and EPR experiment, Different interpretations of Quantum Mechanics, process of measurement : The Decoherence effect , Quantum Physics and Realism. The religious Interpretation of Science, Physics as Metaphor.

References:

1. Physics as Metaphor by R. S. Jones, Wildwood House, 1982.
2. Probabilities of Quantum World by D. Danin, Mir Publishers Moscow, 1983.
3. Q is for Quantum by J. Gribbin, University Press, 1998.
4. Quantum Philosophy by R. Omnes, University Press, 1999.