ಬೆಂಗಳೂರು ಕೇಂದ್ರ ವಿಶ್ವವಿದ್ಯಾಲಯ
BENGALURU CENTRAL UNIVERSITY
Central College Campus, Dr.AmbedkarVeedhi, Bengaluru – 560 001.
Ph. No: 080 – 22131385 / 22191016, E-Mail ID: bcuccb@gmail.com / registrarbcu@gmail.com

No: BCU/BOS/Physics/PG/72/2019-20 Date: 28.01.2020

NOTIFICATION

Sub: Corrigendum to the M.Sc I and II Semesters in Physics Syllabus of Bengaluru Central University

Ref: 1. This office notification no: BCU/BOS/Physics/PG/340/2019-20
2. Letter of the Chairman BoS Physics PG dated: 23.01.2020
3. Vice- Chancellor's approval date:28.01.2020

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The I & II semester Physics P.G Syllabus was notified vide notification referred at (1) above. As per the letter of the Chairman BoS referred at (2) above, the Paper Code No PHY 209 Paper for non-physics students "Introduction to Modern Physics", mentioned under II Semester is required to be introduced in the III Semester under open elective in accordance with the PG Regulations of the University. Hence the said paper PHY 209 Paper-'Introduction to Modern Physics" included under II Semester P.G Physics syllabus, is here by withdrawn.

The updated syllabus for M.Sc I and II Semester is published in the Website of the University www.bcu.ac.in for information of the concerned.

REGISTRAR 28/1/2020

To,

1. The Registrar (Evaluation), BCU.
2. The Dean, Faculty of Science, BCU
3. The Chairman & Members of BoS in Physics (PG), BCU
4. The Co-ordinator, Department of Physics, BCU
5. The Principals of the concerned affiliated Colleges of BCU –through email
6. The P.S. to Vice-Chancellor/Registrar/Registrar(Evaluation), BCU
7. Office copy / Guard file.

BENGALURU CENTRAL UNIVERSITY

Central College Campus, Bengaluru 560001

Papers, Teaching Hours, Examination Marks and Credits for
M.Sc. (Physics) Degree Course (CBCS) effective from 2019-20

Paper Code	Paper Title	Teaching hours per week	Final Exam. Marks	Internal Exam. Marks	Total Marks	Credit hours	Remarks
	First Semester						
PHY101	Mathematical Methods of Physics I	3	70	30	100	3	HC*
PHY102	Classical Mechanics	3	70	30	100	3	HC
PHY103	Classical Electrodynamics	3	70	30	100	3	HC
PHY104	Electronic Circuits and Devices	3	70	30	100	3	HC
PHY105	General Physics Lab	4	35	15	50	2	HC
PHY106	Electronics Lab	4	35	15	50	2	HC
PHY107 PHY108	Renewable Energy sources/ Techniques in Biophysics	3	70	30	100	3	SC** Any one to be chosen
	Total	**23**	**420**	**180**	**600**	**19**	
	Second Semester						
PHY201	Mathematical Methods of Physics II	3	70	30	100	3	HC
PHY202	Quantum Mechanics I	3	70	30	100	3	HC
PHY203	Statistical Mechanics	3	70	30	100	3	HC
PHY204	Atomic, Molecular Physics and Modern Optics	3	70	30	100	3	HC
PHY205	Optics Lab	4	35	15	50	2	HC
PHY206	Computational Physics Lab	4	35	15	50	2	HC
PHY207 PHY208	Experimental Techniques / Modern Spectroscopic Techniques	3	70	30	100	3	SC** Any one to be chosen
	Total	**23**	**420**	**180**	**600**	**19**	

*HC = Hard core, **SC = Soft core

Bengaluru Central University
Syllabus for I Semester of M.Sc. Degree in Physics
CBCS

(Effective from 2019-20)

PHY 101: Mathematical Methods of Physics-I
(Hard Core)

Unit I

Vectors and Matrices: Review of vector algebra and calculus, Gauss and Stokes theorems, Orthogonal coordinates, differential vector operators, special coordinate systems, circular cylindrical coordinates, spherical polar coordinates, tensor analysis, contraction, direct product, quotient rule, pseudo-tensors, dual tensors, non-Cartesian tensors, metric tensor, Christoffel symbols, covariant differentiation.

Different types of matrices, properties of orthogonal, Hermitian, unitary and normal matrices. Independent parameters, eigenvalues and eigenfunctions of matrices, diagonalisation of matrices.

(16 hrs)

Unit II

Special Functions and Calculus of Residues: Second order ordinary differential equations, Frobineus method for solving second order linear ODEs, Legendre's equation, Legendre polynomials and their properties, Bessel's equation, Bessel functions and their properties, Laguerre's equation, its solution and properties, Hermite equation and its solutions, Hermite polynomials and their properties.

Properties of analytic functions, Cauchy-Riemann conditions, Cauchy's integral theorem, Cauchy integral formula. Taylor expansion, Laurent expansion, singularities, Cauchy's residue theorem, evaluation of definite integrals.

(16 hrs)

Unit III

Integral Transforms: Review of Fourier series, generalized Fourier series, expansion of functions in Fourier series, Fourier integrals, Sine and Cosine transforms, Fourier transforms of derivatives, convolution theorem, Parseval's relation, applications. Transfer functions. Laplace transforms, their properties, Laplace transforms of derivatives, convolution theorem, inverse Laplace transformations. Solution of differential equations using Laplace transforms.

(16 hrs)

Text Books:

1. Mathematical methods for physicists, **Arfken G. B and Weber H.J**, 4th Edition, Prism Books Pvt. Ltd, India (1995).
2. Mathematical Methods of Physics, 2nd edition, **Mathews and Walker**, Pearson Education (2004).
3. Mathematical Physics, **P Goswami**, Cengage Learning (2012).

References:

1. Mathematical Physics, **Chattopadhyaya P.K,** Wiley Eastern (1980).
2. Methods of Mathematical Physics, **Bose H.K and Joshi M.C,** Tata McGraw Hill (1984).
3. Vector Analysis, **Murray R Spiegel**, Schaum's Outline Series, McGraw Hill International Book Company, Singapore, (1981).
4. Tensor Analysis – Theory & Applications, **Sokolnikoff I. S,** 2nd Edition, John Wiley & Sons (1964).
5. Mathematical Physics, **Mary L. Boas**, 2nd edition, John Wiley & Sons (1983).
6. Introduction to Mathematical Physics, **Harper**, PHI (1976).
7. Matrix methods and Vector spaces in Physics, **Sharma**, PHI (2009).
8. Mathematical Physics, **Butkov,** Addison-Wesley (1973).
9. Mathematical Physics, **A K Saxena**, Narosa (2015).
10. Mathematical Physics, **Binoy Bhattacharyya**, NCBA (2009).
11. Mathematical Methods in Physics, **S D Lindenbaum**, Allied Publishers (2002).

Syllabus for I Semester of M.Sc. Degree in Physics

CBCS

(Effective from 2019-20)

PHY 102: Classical Mechanics

(Hard Core)

Unit I

Lagrangian Formulation: Constraints and their classification, degrees of freedom, generalized co-ordinates, example of a disk rolling on the horizontal plane, virtual displacement, D'Alembert's principle, Lagrange's equations of motion of the second kind. Simple applications of the Lagrangian formulation: 1.Free particle in (a) Cartesian co-ordinates, (b) plane polar co-ordinates, 2. Atwood's machine, 3. A bead sliding on a uniformly rotating wire in a force-free space. 4. Simple Pendulum. Symmetries of space and time: conservation of linear momentum, angular momentum and energy.

Central Forces: Reduction of two particle equations of motion to the equivalent one-body problem, reduced mass of the system, conservation theorems (First integrals of the motion), equations of motion for the orbit, classification of orbits, conditions for closed orbits, The Kepler problem (inverse-square law of force).

(16 hrs)

Unit II

Scattering in a Central Force Field: General description of scattering, cross-section, impact parameter, Rutherford scattering, center of mass and laboratory co-ordinate systems. Transformation of the scattering angle and cross section between the coordinate systems.

Motion in non-inertial Reference Frames: Motion of a particle in a general non-inertial frame of reference, notion of pseudo forces, equations of motion in a rotating frame of reference, the Coriolis force, deviation due east of a falling body, the Foucault pendulum.

Small Oscillations: Types of equilibriums, Quadratic forms for Kinetic and Potential energies of a system in equilibrium, Lagrange's equations of motion, Normal modes and normal frequencies, examples of (i) longitudinal vibrations of two coupled harmonic oscillators (ii) Normal modes and normal frequencies of a linear, symmetric, tri-atomic molecule.

(16 hrs)

Unit III

Rigid body Dynamics: Degrees of freedom of a free rigid body, angular momentum and kinetic energies of a rigid body, moment of Inertia tensor, principal moments of inertia, classification of rigid bodies as spherical, symmetric and asymmetric, Euler's equations of motion for a rigid body, Torque free motion of a rigid body, precession of earth's axis of rotation, Euler angles, angular velocity of a rigid body, notions of spin, precession and nutation of a rigid body.

Hamiltonian Formalism: Generalized momenta, canonical variables, Legendre transformations and the Hamilton's equations of motion, Examples of (a) The Hamiltonian of a particle in a central force field, (b) the simple harmonic oscillator. Cyclic co-ordinates and conservation theorems, derivation of Hamilton's equations from a variational principle.

Canonical Transformations: Generating functions (four basic types), examples of canonical transformations, the harmonic oscillator in one dimension, Poisson brackets, equations of motion in terms of Poisson Brackets, properties of Poisson brackets (anti-symmetry, linearity and Jacobi identity), The Hamilton-Jacobi equation, Solution of linear harmonic oscillator using Hamilton-Jacobi method.

(16 hrs)

Text Books:

1. Classical Mechanics, **H. Goldstein, C. Poole, J. Saflco**, 3rd edition, Pearson Education (2002).
2. Classical Mechanics, **N. C. Rana and P. S. Joag**, Tata McGraw-Hill (1991).

References:

1. Classical Mechanics, **K. N. Srinivasa Rao**, University Press (2003).
2. Classical Dynamics of Particles and Systems, **J. B. Marion**, Academic press (1970).

3. Introduction to Classical Mechanics, **Takwale and Puranik**, Tata McGraw-Hill (1983).
4. Classical Mechanics, **L. D. Landau and E. M. Lifshitz**, 4th edition, Pergamon press (1985).
5. Classical Mechanics, **G Aruldhas**, PHI, (2012).
6. Classical Mechanics, **Sankar Rao,** PHI, (2009).
7. Classical Mechanics, **P V Panat**, Narosa (2008).
8. Classical Mechanics, **J C Upadhyaya**, Himalaya Pub. House (2012).
9. Classical Mechanics, **B A Kagali and T Shivalingaswamy**, Himalaya Pub. House (2018).

Syllabus for I Semester of M.Sc. Degree in Physics

CBCS

(Effective from 2019-20)

PHY 103: Classical Electrodynamics

(Hard Core)

Unit I

Electrostatics and Magnetostatics: Gauss's law and applications, Electric potential, Poisson's equations; Work, Energy in electrostatics, Laplace equation and its solution in one, two and three dimensional Cartesian co-ordinates, boundary conditions and uniqueness theorem, Method of images with applications, Multipole expansion of potential, Dipole field, Field inside dielectrics, Biot - Savart law and applications, Ampere's law and applications. Magnetic vector potential, Multipole expansion of the vector potential. Magnetisation, The field of a magnetized object, linear and non-linear media.

(16hrs)

Unit II

Electrodynamics and Electromagnetic Waves: Review of Maxwell's equations, formulating electrodynamics using scalar and vector potentials, Gauge transformations, Coulomb and Lorentz gauges,Poynting's theorem, Maxwell's stress tensor, energy and momentum of electromagnetic waves, propagation through linear media, reflection and transmission of electromagnetic waves, Fresnel's equations. Plane waves in conducting media, skin depth, dispersion of electromagnetic waves in nonconductors, wave guides, TE and TM waves in rectangular wave guide. The coaxial transmission line.

(16 hrs)

Unit III

Electromagnetic Radiation: Retarded potentials, electric and magnetic dipole radiation, Lienard - Wiechert potentials, fields of a point charge in motion, power radiated by a point charge, Larmor formula, Bremssstrahlung.

Special Relativity and Maxwell's Equations: Review of Lorentz transformations. Four vectors, magnetism as a relativistic phenomenon, Lorentz transformation of electric and magnetic fields, the electromagnetic field tensor, equations of electrodynamics in tensor notation, potential formulation of electrodynamics.

(16 hrs)

Text Books:

1. Introduction to Electrodynamics, **D.J. Griffths**, Pearson, 4th ed. (2015).
2. Electromagnetics, **B.B. Laud**, New Age International PVT. Ltd. (1987).

References:

1. Electromagnetic Fields and Waves. **P. Lorrain and D. Corson**, CBS (1986).
2. Electromagnetism. **I.S Grant and W.R Phillips**, John Wiley and Sons Ltd. (1975).
3. Electromagnetism, **Pramanik**, 2 vols. PHI (2012).
4. Classical Electrodynamics, **J D Jackson**, Wiley Eastern (1990).
5. Introduction to Electrodynamics, **A Z Capri and P V Panat**, Narosa (2002).
6. Classical Electrodynamics, 2nd ed. **Hans C Ohnian**, Firewall Media (2007).
7. Elements of Electromagnetics, 3rd ed. **M N O Sadiku**, Oxford Univ. Press (2001).

Syllabus for I Semester of M.Sc Degree in Physics

CBCS

(Effective from 2019-20)

PHY 104: Electronic Circuits and Devices

(Hard Core)

Unit I

Physics of Devices: p-n junction, abrupt junction – band structure – thermal equilibrium – depletion region – depletion capacitance – current and voltage characteristics. BJT – band structure - transistor action – static characteristics. Principles of UJT, SCR, thermionic devices and Triac. Metal semiconductor contacts –Ohmic and Schottky contacts - MESFET principle – structure – working- characteristics. Principle of operation of photoelectronic devices: photoconductor – efficiency, current gain, response time. Effect of light on I-V characteristics of a junction photo device, principle and working of a photodiode, light emitting devices. Principle, working and factors affecting the efficiency of LED.

(16 hrs)

Unit II

Transistor Circuits: Review of the Common Base configuration – I-V characteristics – alpha – equivalent circuit-Common collector configuration (the emitter follower) –input and output impedances – gain; Common emitter configuration – I-V characteristics – beta of a transistor - base bias with single supply – gain. Load lines for CE connection – DC load line, ac load line, optimum operating point. Multistage amplifier.AC and DC coupled amplifier. The Darlington pair. Astable multivibrator using transistors, voltage regulator using transistors, transistor difference amplifiers - four configurations, analysis of dual input and dual output configuration – CMRR – Common Mode gain, Difference mode gain.

(16 hrs)

Unit III

Operational Amplifiers: Block diagram of an operational amplifier – Characteristics of an ideal operational amplifier , BJT based and FET based amplifier, comparison with 741 – Operational amplifier as a open loop amplifier - Limitations of open loop configuration – Operational amplifier as a feedback amplifier; closed loop gain, input impedance , output impedance of inverting and non-inverting amplifiers - Voltage follower - Differential amplifier: voltage gain. Applications of op-amp: Linear applications – Phase and frequency response of Low pass, high pass and band pass filters (first order), summing amplifier – inverting and non-inverting configurations, subtractor, difference summing amplifier, ideal and practical Differentiator, Integrator, Schmitt trigger.

Digital Circuits: Review of gates (AND, OR, NAND, NOR, NOT, EX-OR), - Response to AC signals (square wave), – Simplification of POS equations - Simplification using Karnaugh Map technique (4 variables).

(16 hrs)

Text Books:

1. Semiconductor Devices Physics and Technology, **S M Sze**, Second Edition, John Wiley and Sons Inc. Asia (2002).
2. The art of electronics, **Paul Horowitz and Winfield Hill,** Second Edition, Foundation Books (1992).
3. Op-Amps and Linear Integrated Circuits, **Ramakant A Gayakwad**, Third Edition, Eastern Economy Edition (2004).
4. Digital principles and applications, **Donald PLeach and Albert Paul Malvino**, 5th ed., Tata McGraw Hill (2002).

References:

1. Solid State Electronic Devices, **Ben G Streetman, Sanjay Banerjee**, Fifth edition, Pearson Education, (2000).

2. Semiconductor Optoelectronic Devices, **Pallab Bhattacharya**, Second Edition, Pearson education, (1997).
3. Electronic Principles, **A P Malvino**, Sixth Edition, Tata McGraw Hill (1999).
4. Operational Amplifiers with Linear Integrated Circuits, **William Stanley,** CBS Publishers and Distributors (1988).
5. Linear Integrated Circuits, **D Roy Choudhury and Shail Jain**, New Age International (P) Limited (1991).
6. Digital systems, Principles and applications, **Ronald J Tocci and Neal S Widmer,** 8th ed. Pearson Education (2001).
7. Physics of Semiconductor devices, **Shur,** PHI, (1995).
8. Electronic Devices and circuit Theory, **Boylestad & Nashelsky**, Prentice Hall (2002).
9. Physics of Semiconductor Devices, 3rd ed., S M Sze and K K Ng, John Wiley India (2007).

Syllabus for I Semester of M.Sc Degree in Physics

CBCS

(Effective from 2019-20)

PHY 105: General Physics Lab

(Hard Core)

List of Experiments (any eight to be performed)

1. Thermal Conductivity of a material of a rod by Forbe's method
2. Determination of elastic constants of a material of glass plate by Cornu's Interference Method.
3. Verification of Stefan's Law by electrical method.
4. Velocity of sound in a liquid using Ultrasonic Interferometer.
5. Study of vibration of a fixed free bar.
6. Temperature dependence of resistance of a thermistor.
7. Study of thermo- emf as a function of temperature.
8. Determining e/k from diode characteristics.
9. Study of BH curve on an oscilloscope
10. Study of temperature sensors - diodes, platinum resistors and thermocouples.
11. Determining the temperature of a bulb filament and verification of Stefan's law.
12. Study of a torsional transmission line.
13. Study of coupled oscillators.
14. Study of vibrations of a stretched string.
15. Study of a double helix-x ray pattern.

(4 hrs /week)

References:

1. **Worsnop and Flint**, Advanced Practical Physics for students, Asia Pub. (1979).
2. **Singh and Chauhan**, Advanced practical physics, 2 vols. Pragati Prakashan (1976).
3. **Misra and Misra**, Physics Lab. Manual, South Asian publishers (2000).
4. **Gupta and Kumar**, Practical physics, Pragati Prakashan (1976).
5. **Rajkumar and Lal**, Advanced Practical Physics.
6. **Misra and Mohanty**, Advanced Physics Lab manual, South Asian Publ. (2007).
7. **D Chattopadhaay and P C Rakshit,** An Advanced course in practical Physics, NCBA (2015).
8. **H P Shrivastava,** A Textbook of Practical Physics, ABD publishers (2006).

Syllabus for I Semester of M.Sc Degree in Physics

CBCS

(Effective from 2019-20)

PHY 106: Electronics Lab

(Hard Core)

List of Experiments (any eight to be performed)

1. Construction and study of an active low pass, high pass and band pass filte rusing op-amp.
2. Construction and study of RC phase shift oscillator using transistor/ op amp
3. Construction and study of Astable multivibrator using 555 timers.
4. Construction and study of Sine wave and square wave generators.
5. Construction and study of Summing, scaling and averaging amplifier using op-amp.
6. Construction and study of Astable multivibrator using transistors.
7. Construction and study of Twin T notch filter using op-amp.
8. Boolean expression implementation.
9. Fixed voltage regulator using transistors.
10. Frequency response of a Differentiator and integrator using op-amp.
11. Study of a half adder and a full adder.
12. Study of a Push pull amplifier using transistors.
13. Study of Clipping and clamping circuits
14. Construction and study of differentiator and integrator circuits.
15. Study of the universal gate.
16. Study of quadrature oscillator using op amp.
17. Study of MOSFET common source amplifier

(4hrs/ week)

References:

1. Electronics Lab Manual, vols.1 and 2, K A Navas, PHI (2015).
2. Experiments in Basic Electronics, **Grob, Pugh, Ponic**, McGraw Hill (1997).
3. Electronic Principles, experimental manual, **Albert Malvino**,
4. The art of Electronics, **Horowitz and Hill**, CUP (1989).
5. A lab course in Electronics, **Ramalingom and Raghupalanan**,

Syllabus for I Semester of M.Sc. Degree in Physics
CBCS
(Effective from 2019-20)
PHY 107: Renewable Energy Sources
(Soft Core)

Unit I

Solar Energy: Solar constant, spectral distribution of extraterrestrial radiation, Terrestrial Solar radiation geometry, empirical equation for estimating solar radiation, Instruments for measuring solar radiation- Pyranometer, sun shine recorder, solar thermal energy collectors- flat plate collectors, liquid heating flat plate collectors, concentrating type collectors. Thermodynamic limits to concentration, solar cookers, types of solar cookers, solar water heater, solar air heaters, solar distillation, Solar water pumping and solar thermal power plant.
Solar photo-voltaic system, photovoltaic effect, efficiency of solar cells, semiconductor materials for solar cells, solar photovoltaic system, applications of solar photo-voltaic devices.

(16hrs)

Unit II

Wind Energy: Origin and classification of winds. Wind turbines, types of rotors, aerodynamics of wind turbines, wind energy extraction, wind characteristics, horizontal axis wind turbine generator. Modes of wind power generation. Advantages and disadvantages of a wind energy system.
Tidal Energy: tidal characteristics, tidal range, tidal energy estimation, energy and power in a double cycle system, yearly power generation from tidal plants, types of tidal power plants, site selection for power plants, advantages and disadvantages of tidal power.

(16 hrs)

Unit III

Biomass Energy: Biomass resources, biofuels, biogas, producer gas, biomass conversion technologies, biochemical conversion, biomass classification. Biogas technology, factors affecting biogas production, biogas plants – floating drum type plant, fixed dome type. Energy recovery from urban waste, power generation from landfill gas. Power generation from liquid waste. Ethanol from biomass.

Fuel Cells: Operation of an acidic fuel cell, technical parameters of a fuel cell, fuel processor, Methanol fuel cell, alkaline fuel cells, polymer electrolyte membrane fuel cells, advantages fuel cell power plants, energy output of a fuel cell, efficiency and emf of a fuel cell, operating characteristics of fuel cells. **(16 hrs)**

Text Books:

1. Renewable energy sources and emerging technologies, **D P Kothari, K C Singal, R Ranjan,** PHI (2018).
2. Non-conventional sources of energy, **G D Rai,** Khanna publications (1979).

References:

1. Renewable energy technologies, **R Ramesh**, Narosa, (1997).
2. Renewable energy systems, **K M Mittal**, Wheeler pub. (1997).
3. Biomass, energy and environment, **Ravindranath N.H.**, Oxford University Press (1995).
4. Solar Energy, **S P Sukhatme and J K Nayak,** Tata McGraw-Hill (2011).
5. Solar Energy, **H P Garg,** TMH (1997).

Syllabus for I Semester of M.Sc Degree in Physics

CBCS

(Effective from 2019-20)

PHY 108: Techniques in Biophysics

(Soft Core)

Unit I

Physico-Chemical Techniques: Bio molecules, Hydration of macromolecules, role of friction, diffusion, sedimentation, the ultracentrifuge, viscosity, rotational diffusion, flow birefringence measurements, electric birefringence.
Light scattering, small angle X-ray scattering,

Spectroscopic techniques: The electromagnetic spectrum, ultraviolet and visible spectroscopy, circular dichroism, optical rotatory dispersion, Fluorescence spectroscopy, Infrared spectroscopy, Raman spectroscopy, Electron spin resonance.

(16hrs)

Unit II

Light Microscopy: review of geometrical optics, limits of resolution, compound microscope, bright field microscopy, dark field microscopy, phase contrast microscopy, fluorescence microscopy, polarizing microscopy,

Electron Microscopy: electron optics, the transmission electron microscope, the scanning electron microscope, specimen preparation for electron microscopy- preservation, dehydration and replication, image reconstruction, electron diffraction, the tunneling electron microscope, atomic force microscope.

(16 hrs)

Unit III

X-ray crystallography: crystals and symmetries, crystal systems, point groups and space groups, growth of crystals of biological molecules, X-ray diffraction, X-ray data collection, structure solution, refinement of the structure.
NMR spectroscopy: Basic principles of NMR, NMR theory and experiment, classical description of NMR, NMR parameters, the chemical shift, intensity, line width, relaxation parameters, spin-spin coupling, NMR applications in biophysics, determination of macromolecular structure.

(16hrs)

Text Books:

1. Biophysics, **Vasantha Pattabhi and N Gautham**, Narosa (2002).
2. Essentials of Biophysics, **P Narayanan**, New Age International (2000).

References:

1. Biophysics, **J K Mathews**, Pacific Books International (2011).
2. Medical Biophysics, **R N Roy**, Books and Allied (2010).
3. Biophysics- tools and techniques, **Betty Karasek**, NY Research Press (2017).
4. Elementary Biophysics, **P K Srivastava**, Narosa (2011).
5. Biophysics – An introduction, **Zane Bradley**, Larsen and Keler (2017).
6. Biophysics, **Rodney Cotterill**, Wiley (2002).

Syllabus for II semester of M.Sc. Degree Course in Physics

CBCS

(Effective from 2019-20)

PHY 201: Mathematical Methods of Physics-II

(Hard Core)

Unit I

Partial Differential Equations: Classification of PDEs, systems of surfaces and characteristics, examples of hyperbolic, parabola and elliptic equations, solution by the method of direct integration, method of separation of variables, the wave equation, Laplace equation, heat conduction equations and their solutions in Cartesian coordinate system in one, two and three dimensions, plane polar coordinates, cylindrical polar and spherical polar coordinates, spherical harmonics and their properties.

Green's Functions and Integral Equations: Boundary value problems, Sturm-Liouville theory, self adjoint operators, Dirac delta functions and its properties, Green's functions for one, two and three dimensional equations, eigen function expansion of Green's functions, Fredholm and Volterra type integral equations, solution of equations with separable kernals. Neumann series method, examples. Non-homogeneous integral equations.

(16 hrs)

Unit II

Group Theory: Definition and examples of groups, symmetry group of a square, multiplication table, classes and subgroups, cyclic groups, direct product of groups, isomorphism and homomorphism, permutation group, reducible and irreducible group representations, Schur's lemmas, examples, Topological and Lie groups, connectedness and compactness, group generators, representation of a continuous group, SO(2), SO(3) and SU(2) groups and their representation, The Lorentz group.

(16 hrs)

Unit III

Numerical Techniques and C programming: Solution of linear algebraic equations using matrix method, solution of transcendental equations by bisection, iteration and Newton-Raphson methods, curve fitting by least squares method, Numerical integration by trapezoidal and Simpon's rules, numerical solutions of differential equations by Euler's and Runge-Kutta methods. Fundamentals of languages, operators and expressions, control statements, functions and programs. C and Python examples.

(16hrs)

Text Books:

1. Mathematical methods for physicists, **Arfken. G**, 5th edition, Academic press (2001).
2. Group Theory for Physicists, **A W Joshi**, New Age International (1997).
3. Introductory methods of Numerical Analysis, **S SSastry**, PHI (2003).
4. Introduction to partial differential equations, **Sankar Rao**, PHI (2006).
5. Python for Beginners, **Harsh Bhasin**, New Age International (2019).

References:

1. Mathematical physics, **Sathyaprakash,** Sultan Chand and sons (1985).
2. Mathematical physics, **Chattopadhyaya P.K.**, Wiley Eastern (1980).
3. Methods of Mathematical Physics, **Bose. H.K. and Joshi M.C**. Tata McGraw Hill (1984).
4. Tensor Analysis, **Sokolnikoff I.S.**, John Wiley (1951).
5. Programming in ANSI C, 6th ed., **E. Balaguruswamy**, TMH (2012).
6. C programming, **Kanitkar,**
7. Programming with C, **Byron Gottfried**, Schaum's outline series, TMH, (1996).
8. A Book on C, 4th ed., **A Kelly, J Pohl**, Pearson (2009).
9. C by Example, **N Kalicharan**, CUP, (2005).
10. C: The Complete Reference, 4th ed., **H Schildt**, TMH (2000).
11. Python the Complete Reference, **Martin Brown**, McGrawHill India (2018).

Syllabus for II Semester of M.Sc Degree in Physics

CBCS

(Effective from 2019-20)

PHY 202: Quantum Mechanics I

(Hard Core)

Unit I

Introductory concepts: Wave-particle duality, the wave function and its interpretation, Physical conditions for a wave function. Free particle wave function, Wave packets, Gaussian wave packet evolution, Heisenberg Uncertainty principle and illustrations, Time - energy uncertainty, complementarity principle .

Time dependent Schrodinger equation, Conservation of probability, expectation values and operators, Ehrenfest's theorems, Time-independent Schrodinger equation, stationary states, energy quantization, properties of the energy eigen funtions, general solution for a time-independent potential, Schrodinger equation in momentum space.

One-dimensional problems: The free particle, momentum eigen functions, the potential step, reflection coefficient, the potential barrier, transmission and reflection coefficients, the infinite square well, parity, finite square well, linear harmonic oscillator, energy levels and eigen functions, comparison with classical theory, the periodic potential.

(16 hrs)

Unit II

The general formalism: Linear vector space. State of a system, dynamical variables and operators, expansions in eigen functions, commuting observables, compatibility and Heisenberg uncertainty relations, Unitary transformations, matrix representations of wave functions and operators, Linear harmonic oscillator by operator method. Time evolution of a system, the virial theorem, Schrodinger equation for a two-body system, Schrodinger and Heisenberg pictures, path integrals. Symmetry principles and conservation laws. Space reflection and parity conservation, time reversal invariance.

(16 hrs)

Unit III

Angular momentum: Orbital angular momentum, spatial rotations, Eigen functions and eigenvalues of L^2 and L_z Operators, particle on a sphere and the Rigid rotator, General angular momentum, the spectrum of $J^2 and J_z$, Matrix representation of angular momentum operators, spin angular momentum, spin one-half, Pauli spin matrices, total angular momentum, addition of angular momenta, addition of orbital angular momentum and spin of a particle, addition of two spin ½.CG coefficients. Effect of rotations on wave functions and operators.

(16 hrs)

Text Books:

1. Quantum Mechanics, **B.H. Bransden and C.J. Joachain**, 2nd Edition, Pearson Education (2004).
2. Introduction to Quantum Mechanics, **David J. Griffiths**, 2nd Edition, Pearson Education (2005).
3. Principles of Quantum Mechanics, 2nd ed., **R Shankar**, Springer (2008).

References:

1. Modern Quantum Mechanics, **J.J. Sakurai**, Pearson Education (2000).
2. Principles of Quantum Mechanics, **Ghatak and Lokanathan**, Macmillan (2004).
3. Quantum Physics, **Stephen Gasiorowicz**, John Wiley (2003).
4. Quantum Mechanics, **E. Merzbacher**, John Wiley (1999).
5. Quantum Mechanics, **Powell and Crasemann**, IBH (1964).

6. Quantum Mechanics, **Agarwal and Hariprakash**, PHI.
7. Quantum mechanics, **S N Biswas**, Books and Allied (2010).
8. Quantum Mechanics, **G Aruldhas**, PHI (2009).
9. A textbook of Quantum Mechanics, **P M Mathews and K Venkatesan**, TMH (2010).
10. Quantum Mechanics, **J Guha**, Books and Allied (2013).

Syllabus for II semester of M. Sc. Degree Course in Physics
CBCS
(Effective from 2019-20)
PHY 203: Statistical Mechanics
(Hard Core)

Unit I

Introduction to Statistical Description: The state of a system, statistical ensemble, basic postulates, probability calculations, density of states, thermal and mechanical interactions between macroscopic systems, quasi-static processes, work done by pressure, equilibrium conditions and constraints, reversible and irreversible processes, distribution of energy between systems in equilibrium, temperature, heat reservoirs, statistical description of isolated systems, systems in contact with heat reservoirs, simple applications of the canonical distribution, calculation of mean values in a canonical ensemble, connection with thermodynamics, grand canonical and other ensembles

Simple applications of statistical mechanics: Partition functions and their properties, thermodynamic quantities of ideal monoatomic gas, Gibbs paradox, entropy of ideal gas, validity of the classical approximation, the equi-partition theorem and its applications, specific heats of solids, Einstein's theory, paramagnetic susceptibility, Maxwell velocity distribution and its applications.

(16hrs)

Unit II

Quantum statistics of ideal gases: Identical particles and symmetry requirements, formulation of the statistical problem, quantum distribution functions, photon statistics, Fermi-Dirac statistics, Bose-Einstein statistics, Maxwell-Boltzmann statistics, quantum statistics in the classical limit, quantum states of a single particle, evaluation of partition function, black body radiation, conduction electrons in metals, electronic specific heat. Equations of state of FD and BE gases Bose-Einstein condensation. MB statistics as a limiting case of BE and FD statistics, Pauli's theory of paramagnetism, BE condensation.

(16 hrs)

Unit III

Irreversible processes and fluctuations: Transition probabilities and master equation for an isolated system, system in contact with a heat reservoir, magnetic resonance, Overhauser effect, Langevin equation for Brownian motion, mean square displacement, relation between dissipation and the fluctuating force, Fourier analysis of random functions, ensemble and time averages, Wiener-Khintchine relations, Nyquist's theorem and equilibrium conditions, Fluctuations and Onsager relations, symmetry properties. Examples.

(16 hrs)

Text Books:

1. Fundamentals of Statistical and Thermal physics, **F. Reif**, McGraw Hill (1985).
2. Statistical Mechanics, **R. K. Pathria**, 2nd edition, Pergamon Press (1972).
3. Statistical mechanics, **D A McQuarrie**, Viva books (2015).

References:

1. Statistical Mechanics, **K. Huang**, Wiley Eastern Limited, New Delhi (1975).
2. Statistical Mechanics and Properties of matter, **E. S. R. Gopal**, Macmillan, India (1976).
3. Elementary Statistical Physics, **Kittel**, John Wiley, New York, (1958).
4. Statistical Physics, **Landau and Lifshitz**, Pergamon Press, Oxford (1974).
5. Statistical Mechanics, **Srivastava and Ashok**, PHI
6. Introduction to Statistical Physics, **S R A Salinas**, Springer Intl, (2009).
7. Fundamentals of Statistical Mechanics, **B B Laud**, 2nd ed., New Age Internatl. (2015).
8. Introduction to Statistical Mechanics, **S K Sinha**, Narosa (2005).
9. Statistical Mechanics, **Shang-Keng Ma**, World Scientific (1998).
10. Statistical Physics, **J K Bhattacharjee**, Allied Publishers (1997).

Syllabus for II Semester of M.Sc Degree in Physics

CBCS

(Effective from 2019-20)

P204: Atomic physics, Molecular Physics and Modern Optics

(Hard Core)

Unit I

Atomic Physics: Brief review of early atomic models of Bohr and Sommerfeld. One electron atom: Quantum states, Atomic orbitals, spectrum of hydrogen, Rydberg atoms (brief treatment), Relativistic corrections to spectra of alkali atoms: Spin-orbit interaction and fine structure in alkali spectra. Two electron atom: Ortho and para states of helium and role of Pauli principle, level schemes of two electron atoms. Perturbations in the spectra of one and two electron atoms: Zeeman effect, Paschen-Back effect, Stark effect in hydrogen spectra. Hyperfine interactions and 21cm line of hydrogen.

Molecular spectra: Electromagnetic radiations from molecules, representation of spectra, basic elements of practical spectroscopy, widths and intensities of spectral lines, Fourier transform spectroscopy, Microwave spectroscopy- rotation of molecules, rotational spectra of diatomic molecules, rigid rotator, intensities of spectral lines, isotopic substitution, non-rigid rotator, spectrum of a non-rigid rotator, experimental techniques and instrumentation.

(16 hrs)

Unit II

Infrared and Raman Spectroscopy: Diatomic molecule as a simple harmonic oscillator, anharmonicity, diatomic vibrating rotator, vibration rotation spectrum of carbon monoxide, vibrations of polyatomic molecules, influence of rotation on the spectra of polyatomic molecules, linear molecules, symmetric top molecules, experimental technique and IR spectrometer, Fourier transform spectroscopy. Raman spectroscopy: quantum theory of Raman effect, pure rotational Raman spectra, vibrational Raman spectra, polarization of light and Raman effect, Structure determination from Raman and Infrared spectroscopy.

(16 hrs)

Unit III

Modern Optics: Coherence of light, spatial and temporal coherence, Einstein's coefficients: spontaneous and stimulated emission, Masers, the idea of light amplification, characteristics of a laser beam, threshold condition for laser oscillation, role of resonant cavity, He-Ne lasers, applications of lasers. Holography: Fundamentals of 3D mapping of images, recording and reconstruction, applications in microscopy and interferometry. Fiber optics: Mechanism of light propagation in a fiber wave guide, numerical aperture, types of optical fibers, transmission characteristics of optical fibers-attenuation and dispersion in fibers.

(16 hrs)

Text Books:

1. Physics of atoms and molecules, **Bransden and Joachain**, (2nd Edition) Pearson Education, (2004).
2. Fundamentals of Molecular Spectroscopy, **Banwell and McCash**, Tata McGrawHill, (1998).
3. Optics (classical and quantum), **R K Kar**, Books and Allied, (2008).

References:

1. Introduction to Atomic Spectra, **H E White**, Mcgraw Hill.
2. Modern Spectroscopy, **J.M. Hollas**, John Wiley, (1998).
3. Molecular Quantum Mechanics, **P.W. Atkins and R.S. Friedman**, Third Edition, Oxford Press (Indian Edition), (2004).
4. Spectra of Diatomic molecules, **G Herzberg**, Van Nostrand, (1950).
5. Lasers, **Silfvast**, Cambridge Univ. Press, (1998).
6. Lasers, **Nambiar**, New Age International, (2004).

7. Optical Electronics, **Ghatak and Tyagarajan**, Cambridge Press, (2004).
8. Lasers and Nonlinear Optics- **B.B. Laud**, Wiley-Eastern Ltd. (1991).
9. Optics, **M V Klein and T E Furtak**, John Wiley, (1986).
10. Atomic and Molecular Spectra and lasers, **A K Saxena**, CBS, 2009.
11. Spectroscopy, 24th ed., **B K Sharma**, Goel Pub. House, (2015).

Syllabus for II Semester of M.Sc. Degree in Physics

CBCS

(Effective from 2019-20)

PHY 205: Optics Lab.

(Hard Core)

List of Experiments (any eight to be performed)

1. Analysis of rotation- vibration spectrum of a diatomic molecule.
2. Experiments with photocells
3. Study of interference and diffraction with laser light.
4. Study of Edser-Butler fringes.
5. Determination of the absorption coefficient of a solution.
6. Study of elliptically polarized light.
7. Study of Rotatory dispersion.
8. Experiments with Michelson Interferometer.
9. Determining the size of Lycopodium powder particles
10. Experiments with a digital CDS
11. Fabry-Perot Etalon experiments
12. Babinet Compensator Experiments
13. Frank Hertz experiment.
14. Hartman's constant determination.

(Experiments may be added whenever necessary) **(4hrs/week)**

References:

1. Advanced practical physics for students, **Worsnop and Flint,** Asia Pub. (1979).
2. Advanced practical physics, 2 vols, **Singh and Chauhan,** Pragati Prakashan (1976).
3. Physics Lab. Manual, **Misra and Misra,** South Asian Publishers (2000).
4. Practical physics, **Gupta and Kumar,** Pragati Prakashan (1976).
5. Experiments in Modern Physics, **H Mark, N Thomas Olson,** McGraw Hill (1966).

Syllabus for II Semester of M.Sc Degree in Physics

CBCS

(Effective from 2019-20)

PHY 206: Computational Physics Lab.

(Hard Core)

List of Computer Exercises (using C^{++} / Python) (any eight to be performed)

1. Exercises with Linux fundamentals (4 sessions)
2. Exercises with LaTex fundamentals (4 sessions)
3. Exercises with Gnuplot (2 sessions)
4. Roots of a quadratic equation
5. Study of projectile motion
6. Linear and non-linear least squares fitting for given data
7. Matrix multiplication
8. Solution of simultaneous equations.
9. Bisection method for solving equations.
10. Euler method for solving differential equations.
11. Newton-Raphson method for solving equations.
12. Simpon's $1/3^{rd}$ rule method for integrating a function.
13. Runge-Kutta 2^{nd} order method for integration.
14. RK4 method for solving differential equations
15. Eigenvalues of a matrix
16. Determinant of an equation
17. Inverse of a matrix
18. Error calculations for a given data
19. Monte Carlo methods for solving equations.

(Linux platform to be used for the above exercises)

(Exercises may be added whenever necessary) **(4 hrs / week)**

References:

1. Computational Physics, **R C Verma, P K Ahluwalia, K C Sharma**, New Age International (2007).
2. Computational Physics, **D Walker**, Medtec (2015).
3. Computer simulation in physics, **R C Verma**, Anamaya publishers (2004).
4. Numerical Analysis and Computational Procedures, **S A Mollah and S Banerjee**, Books and Allied (2009).
5. A First Course in Computational Physics, **P L DeVries and J E Hasbun,** Jones and Bartlett Learning (2011).
6. LaTeX Beginer's guide, **S. Kottwitz**, (2011)
7. Linux: The Complete Reference, 6th ed., **R Peterson**, TMH (2008).
8. Linux Bible, 8th ed., **Christopher Negus**, John Wiley (2012).

Syllabus for II Semester of M.Sc Degree in Physics

CBCS

(Effective from 2019-20)

PHY 207: Experimental Techniques

(Soft Core)

Unit I

Temperature measurements: Resistance thermometers, Thermistors, Thermocouples, Semiconductor temperature sensors, Thermal radiation temperature measurements, Infrared pyrometers, disappearing filament Optical Pyrometer.

Low temperature thermometry: Magnetic thermometers, Noise thermometry, the melting curve thermometer.

Electrical Measurements at high frequencies: Resonance methods, Measurement of inductance, Capacitance, effective resistance, measurement of R, L, C, and ω through T-network at high frequencies, Q meter, methods of measurements of Q.

(16 hrs)

Unit II

Vacuum techniques: Characteristics of Vacuum, Applications of vacuum (surface physics, Particle accelerators, thin film evaporation, vacuum melting, sputtering etc.). Pumping speed, pumping time, effective pumping speed-conductance, leak testing for a vacuum system.

Vacuum systems: Construction of vacuum equipment, vacuum pumps, rotary vane, diffusion pump. Turbo molecular pump, sorption pump, cryopump, sputter or getter ion pumps.

Vacuum gauges: Pirani gauge, Penning cold cathode gauge, capacitance gauge, ionisation gauge,

(16 hrs)

Unit III

Magnetic Sensors: Magnetic Field Sensors—Classification, Specification of the Performances of Magnetic Sensors.

Induction Sensors: Air Coils versus Ferromagnetic Core Coils, Moving Coil Sensor, Gradiometer Sensor, Rogowski Coil, Flux Ball Sensor, Fluxgate Sensor: Principle of Operation, Performances of Fluxgate Sensors.

Magnetoresistive and Magnetoimpedance Sensors: AMR Magnetic Field Sensors, Spin-dependent tunneling, GM R Magnetic Field Sensors, Giant Magneto impedance Sensors.

Hall-Effect Sensors: Physical principles of the Hall Effect, Performance of the Hall Sensors, Integrated Circuit Hall Sensors, Hall-Effect-Based Semiconductor magnetoresistors.

SQUID Sensors: Operating Principle of SQUID Sensors, Properties of SQUID Sensors, SQUID Magnetometers.

Resonance Sensors and Magnetometers: NMR Magnetometers for Measurements of Strong Magnetic Fields, NMR Magnetometers for Measurements of weak magnetic fields. Basic principles of MRI (qualitative).

(16 hrs)

Textbooks:

1. Measurment instrumentation and experiment design in physics and engineering, **Michael Sayer, Abhai Mansingh,** PHI (2015).
2. Hand book of magnetic measurements, **S Tumanski,** CRC Press (2011).

References:

1. Scientific Foundations of Vacuum Technique, 2nd Ed., **S Dushman,** John Wiley (1962).
2. Electrical, Electronics measurements and instruments, **Umesh Sinha,** Satya Prakashan, Reprint edition (2005).

Syllabus for II Semester of M.Sc Degree in Physics
CBCS
(Effective from 2019-20)
PHY 208: Modern Spectroscopic Techniques
(Soft Core)

Unit I

Absorption and emission spectroscopy- Electromagnetic radiation, electromagnetic spectrum, atomic energy levels, molecular electronic energy levels, vibrational energy levels, Raman effect, lasers, nuclear spin, electron spin, x-ray energy levels.

Ultraviolet and visible spectroscopy- Radiation sources, wavelength selection, prisms and gratings, cells and sampling devices, detectors, photo multiplier tubes, photodiodes, instruments for absorption photometry, single and double beam instruments.

(16 hrs)

Unit II

Ultraviolet and visible absorption methods – Laws of photometry, Beer's law, photometric precision, quantitative methodology, Differential or expandable scale spectroscopy, Derivative spectroscopy.

Fluorescence and Phosphorescence Spectro-photometry: Structural factors, photoluminescence power as related to concentration, instrumentation, fluorescence lifetime measurements, phosphorescence measurements, room temperature phosphorescence.

(16 hrs)

Unit III

Infrared spectrometry – Correlation of infrared spectra with molecular structure, instrumentation, radiation sources and detectors, dispersive spectrometers, Fourier transform infrared spectrometer, sample handling, quantitative analysis,

Raman Spectroscopy – Raman effect, resonance Raman spectroscopy, instrumentation, sample handling, illumination, structural analysis, polarization measurements, Comparison of Raman spectroscopy with Infrared spectroscopy.

(16 hrs)

TextBooks:

1. Instrumental Methods of Analysis, 7th edition, H. **Willard, L L Merritt, J A Dean, F A Settle**, CBS publishers (1986).
2. Principles of Instrumental Analysis, 5th ed., **D A Skoog, F J Haller, T A Nieman**, Harcourt Asia (2001).

References:

1. Fundamentals of Molecular Spectroscopy, **Banwell and Mc Cash**, TMH (1995).
2. Basic Principles of Spectroscopy, **Chang,** Krieger (1978).
3. Spectroscopy, vol 1-3, **Straughn and Walker**, Chapman and Hall (1976).
4. Spectroscopy, 4th ed., **Lampman, Pavia, Kriz and Vyvan**, Cengage Learning (2010).

23.01.2020
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