Choice Based Credit System
B.Sc. Physics Syllabus
(6 Semester Degree Course)

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[as per CBCS Regulations(UG) of Mizoram University]

Mizoram University, Aizawl
November - 2015

A.Course Structure of CBCS B.Sc.(Physics)
(6 Semester Degree Course)

B. Course Structure & Marks Distribution
6 Semester B.Sc.(Physics) Course

Sem	Course No.	Name of Paper	Marks Scale			Credit				Exam(hrs)	
			C/A	End Sem.	Tot	L	T	P	Tot	Th	Pr
1st	ENG/I/FC/01	English I	25	75	100	4	1	0	**5**	*3*	-
	PHY/I/EC/01(T)	Properties of Matter, Oscillations & Acoustics	25	75	100	3	1	0	**4**	3	-
	PHY/I/EC/01(P)	Laboratory-I	25	75	100	0	0	2	**2**	-	3
	Elective Course-1	Theory	25	75	100				**4**		
		Practical	25	75	100				**2**		
	Elective Course-2	Theory	25	75	100				**4**		
		Practical	25	75	100				**2**		
			175	525	**700**				**23**		
2nd	ENG/II/FC/02	English II	25	75	100	4	1	0	**5**	*3*	-
	PHY/II/EC/02(T)	Thermodynamics & Mathematical Physics-I	25	75	100	3	1	0	**4**	3	-
	PHY/II/EC/02(P)	Laboratory-II	25	75	100	0	0	2	**2**	-	3
	Elective Course-1	Theory	25	75	100				**4**		
		Practical	25	75	100				**2**		
	Elective Course-2	Theory	25	75	100				**4**		
		Practical	25	75	100				**2**		
			175	525	**700**				**23**		
3rd	HSCI/III/FC/03	History of Science	25	75	100	4	1	0	**5**	*3*	-
	PHY/III/EC/03(T)	Electromagnetism and Optics	25	75	100	3	1	0	**4**	3	-
	PHY/III/EC/03(P)	Laboratory-III	25	75	100	0	0	2	**2**	-	3
	Elective Course-1	Theory	25	75	100				**4**		
		Practical	25	75	100				**2**		
	Elective Course-2	Theory	25	75	100				**4**		
		Practical	25	75	100				**2**		
			175	525	**700**				**23**		
4th	EVS/IV/FC/04	Environmental Studies	25	75	100	4	1	0	**5**	*3*	-
	PHY/IV/EC/04(T)	Atomic, Nuclear Physics-I and Solid State Physics-I	25	75	100	3	1	0	**4**	3	-
	PHY/IV/EC/04(P)	Laboratory-IV	25	75	100	0	0	2	**2**	-	3
	Elective Course-1	Theory	25	75	100				**4**		
		Practical	25	75	100				**2**		
	Elective Course-2	Theory	25	75	100				**4**		
		Practical	25	75	100				**2**		
			175	525	**700**				**23**		
5th	PHY/V/CC/05(T)	Mathematical Physics-II	25	75	100	3	1	0	**4**	3	-
	PHY/V/CC/06(T)	Electronics-I	25	75	100	3	1	0	**4**	3	-
	PHY/V/CC/07(T)	Classical Mechanics and Nuclear Phys-II	25	75	100	3	1	0	**4**	3	-
	PHY/V/CC/05(P)	Laboratory-V	25	75	100	0	0	3	**2**	-	3
	PHY/V/CC/06(P)	Laboratory-VI	25	75	100	0	0	3	**2**	-	3

	PHY/V/CC/07(P)	Laboratory-VII	25	75	100	0	0	3	**2**	-	3
	PHY/V/CC/08(a)(T) PHY/V/CC/08(b)(T)	**Optional Paper I** (any one) Atomic & Molecular Spectroscopy C-Language and Num. Methods	25	75	100	3	1	0	**4**	3	-
	PHY/V/CC/08(P)	Laboratory-VIII	25	75	100	0	0	2	**2**	-	3
			200	600	**800**				**24**		
6th	PHY/VI/CC/09(T)	Quantum Mechanics	25	75	100	3	1	0	**4**	3	-
	PHY/VI/CC/10(T)	Electromagnetic Theory	25	75	100	3	1	0	**4**	3	-
	PHY/VI/CC/11(T)	Thermal and Statistical Physics	25	75	100	3	1	0	**4**	3	-
	PHY/VI/CC/09(P)	Laboratory-IX	25	75	100	0	0	3	**2**	-	3
	PHY/VI/CC/10(P)	Laboratory-X	25	75	100	0	0	3	**2**	-	3
	PHY/VI/CC/11(P)	Laboratory-XI	25	75	100	0	0	3	**2**	-	3
	PHY/VI/CC/12(a)(T) PHY/VI/CC/12(b)(T)	**Optional Paper II (any one)** Solid State Physics-II Electronics-II	25	75	100	3	1	0	**4**	3	-
	PHY/VI/CC/12(P)	Laboratory - XII/Project	25	75	100	0	0	2	**2**	-	3
			200	600	**800**				**24**		
		Grand Total	1100	3300	**4400**				**140**		
			Theory Credit						**100**	**(71.4%)**	
			Practical Credit						**40**	**(28.6%)**	

Key Points:

1. In teaching all the courses of Physics, S.I. units will be followed.
2. Contact hour per Lecture is 1 hour. For Theory, 1 Contact hour is 1 Credit and for Practical, 2 Contact hours is 1 Credit.
3. Internal Tests/Assignments will be conducted as a part of Internal Assessment as per CBCS Regulations (UG) of Mizoram University.

C. Core and Elective Papers

The permitted combinations of Core and Elective papers for Physics are as given below:

Core	**Elective I**	**Elective II**
Physics	Mathematics	Chemistry/Electronics/Geology/Statistics
Chemistry	Mathematics	**Physics**/Statistics
Mathematics	**Physics**/Statistics	Chemistry/Electronics/Geology
Geology	**Physics**	Mathematics/Statistics

D. Examination Pattern

- Internal Tests as per CBCS guidelines for UG (MZU)
- In the End Semester examinations, following is the marks distribution and the pattern of setting the questions in Theory and Practical Papers.
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Papers with Marks	**Internal (C1+C2) - 25 marks** **Marks distribution** As per CGS guidelines for UG	**External (C3) – 75 marks**	**Duration of Examn.**
Core & Optional (Theory) 75	**External (C3)** A.*Objective Type Questions* (Part A) **-25 marks** No. of MCQ to be set = **10** (**1** marks) No. of MCQ to be answered = **10** B. *Short Answer Type* No. of S.A. Qs. to be set= **10** (2 from each Unit with **3** marks) No. of S.A. Qs. to be answered= **5** (1 from each Unit)	**External (C3)** C. *Descriptive Questions* (Part B) **– 50 marks** No. of Qs. to be set = **10** (2 from each Unit with **10** marks) No. of Qs. to be answered = **5** (1 from each Unit)	3 hours
Practical 100	**Internal (C1+C2=25 marks)** For PHY/I/EC/01(P), PHY/II/EC/02(P), PHY/III/EC/03(P),PHY/IV/EC/04(P), PHY/V/CC/05(P),PHY/V/CC/06(P), PHY/V/CC/07(P),PHY/V/CC/08(P), PHY/VI/CC/09(P),PHY/VI/CC/10(P), PHY/VI/CC/11(P),PHY/VI/CC/12(P) **Marks distribution** As per CGS guidelines for UG	**External (75 marks)** End Semester–**50** marks, Record Book – **10** marks, Attendance – **5** marks, Viva Voce – **10** marks Total = **75** marks	3 hours

E. Internal and External Examination

Examination and Assessment: Each Course, shall be evaluated at the scale of 100. For all courses, irrespective of Theory and Practical, there shall be Continuous (Internal) Assessment carrying 25 marks and an End-semester examination carrying 75 marks.

1) **Continuous Assessment:**
The outline for Continuous Assessment activities shall be proposed by the teacher(s) concerned before the commencement of the semester. Some suggested parameters of Continuous Assessment are Class Tests, Seminar, Quiz, Home Assignments, Project, and many other methods. However, there shall be series of tests at regular intervals for each course (paper) incorporating various parameters as given above. Final marks shall be calculated for total 25 Marks.
The scheme of awarding marks in Internal Assessment for Theory courses shall be as below:

Component (C1+C2)	**Total marks**
Class Tests (Best two out of three)	12 marks
Assignment/Seminar/Project etc.	8 marks
Regularity in the class	5 marks

The scheme of awarding marks in Internal Assessment for Practical courses shall be as given below:

Evaluation in the Lab and Record	8 marks
End-semester Test	12 Marks
Regularity in the class	5 Marks

Attendance evaluation for each course shall be as given in below:

Attendance	**Marks**
90% and above	5
85 to 89.9%	4
80 to 84.9%	3
76 to 79.9%	2
75 to 75.9%	1

2) The End-semester Examination
For each Course (separately for Theory and Practical), End-semester examination(C3) shall be conducted for 75 marks each. Finally, the marks obtained in Internal Assessment and End-semester Examination in each course shall be pooled and the % marks obtained shall be calculated by the Examination Department

First Semester

Properties of Matter, Oscillations and Acoustics

Course No: PHY/I/EC/01(T)

Marks Scale: 100 marks **Credit: 4**
(End Sem.: 75+ Int.: 25) **(3- 1- 0)**

Unit-1: (10 Lectures)

Laws of motion: Newton's laws of motion, components of velocity and acceleration in Cartesian system, Plane polar coordinate system, Uniformly rotating frame, centripetal acceleration, Coriolis force and its applications, Centre of mass and its equation of motion, Collision: Elastic and inelastic collisions, conservation of energy, linear and angular momenta, Conservative and non-conservative forces. Gravitation: Newton's law of gravitation, gravitational field and potential, gravitational field and potential due to a spherical body.

Unit-2: (10 Lectures)

Rotational motion: angular velocity, moments of inertia and its physical meaning, radius of gyration, torque, theorems on moment of inertia, calculations of moment of inertia in the cases of rectangular body, elliptical disc, ring, solid cylinder, spherical shell.

Special theory of Relativity: Inertial and non-inertial frames, Galilean invariance, Newtonian relativity, Einstein's basic postulates, Lorentz transformations, length contraction, simultaneity, time dilation, twin paradox, Variation of mass with velocity, mass energy equivalence, relativistic formulae for momentum and energy.

Unit-3: (10 Lectures)

Elasticity: small deformations, Hooke's law, elastic constants for an isotropic solid, inter relations of elastic constants, torsion of a cylinder, Bending of beams, bending moments.

Kinematics of moving fluids: rate of flow, equations of continuity, Bernoulli's theorem, viscous fluids, viscosity and coefficient of viscosity, streamline and turbulent flow, Reynold's number, Poiseulle's law, Stokes law.

Surface tension and surface energy: molecular interpretation of surface tension, pressure on a curved liquids surface, angle of contact, capillarity, determination of surface tension by capillary rise method.

Unit-4: (10 Lectures)

Harmonic oscillations: differential equation and its solution, kinetic and potential energy, examples of simple harmonic oscillations, spring and mass system, simple and compound pendulum, torsional pendulum. Superposition of two simple harmonic motions of the same frequency, superposition of two mutually perpendicular simple harmonic vibrations of the same frequency, Lissajous figures.

Standing waves: Standing waves, as normal modes of sounding system, harmonics and quality of sound, Chladnis figures.

Unit-5: (10 Lectures)

Free and forced vibration: conditions of maximum amplitude, resonance and condition of resonance, sharpness of resonance. Noise & Music: The human ear and its responses, limits of human audibility, intensity and loudness, musical scale, noise pollution, its implication and remedy.

Auditorium acoustics: Sabine's law, reverberation, time of reverberation, live and dead rooms, Ultrasonics: production, detection and application of ultrasonic waves.

Recommended Books:

1. R Sengupta and H. Chatterjee: *A Treatise on General Proper*
2. *ties of Matter*, New Central Agency, Calcutta
3. D.S. Mathur: *Elements of Properties of Matter*, S. Chand & Co.
4. R P Feynman, R B Leighton and M Sands: *The Feynman Lectures in Physics,* Vol.1, B I Publications (Bombay, Delhi, Calcutta, Madras)
5. S. Garg, C.K. Ghosh, S. Gupta: *Oscillations and Waves*, PHI India Ltd
6. P.K. Chakraborty and SB Choudhury: *A Textbook on Waves and Acoustics*, Central Agency Kolkata.
7. R.K.Thapa, Shivraj Gurung and R. C. Tiwari: *A Textbook of Sound*, Zoram Book House.

First Semester

Laboratory-I

Course No: PHY/I/EC/01(P)

Marks Scale: 100 marks **Credit: 2**

(End Sem.: 75+ Int.: 25) **(0- 0- 2)**

One (1) experiment is to be performed within 3 hours in the End Semester examination. A minimum of 4 experiments is to be performed by the students.

1. Determine the acceleration due to gravity by bar pendulum.
2. Determine the Young's modulus of a wire by Searle method.
3. Determine the co-efficient of viscosity of water by capillary method.
4. Determine the refractive index of a liquid/solid by using a traveling microscope.
5. Determination of surface tension of a liquid by capillary rise method.
6. Determine the frequency of tuning fork by Meldes' experiment.
7. Verify laws of vibrations of strings by using a sonometer.

Recommended Books:

1 K. G. Majumdar and B. Ghosh: *A Textbook of Practical Physics*, Vol-I&II, Sreedhar Publications, Kolkata.

2 H Singh: *B.Sc. Practical Physics*, S. Chand & Co. Ltd. (latest edition)

3. C.L. Arora: *Practical Physics*, S. Chand & Co., Delhi.
4. S. K. Ghosh: *A Textbook of Practical Physics*, New Central Book Agency, Kolkata
5. C. R. Dasgupta: *A Textbook of Practical Physics*, Book Syndicate(P) Ltd, Kolkata

Note: *Experiments may be added or deleted subject to the availability of facilities in the College.*

Second Semester

Thermodynamics and Mathematical Physics-I

Course No: PHY/II/EC/02(T)

Marks Scale: 100 marks **Credit: 4**
(End Sem.: 75+ Int.: 25) **(3- 1- 0)**

Unit-1: (10 Lectures)

Ideal gas: Kinetic model, Kinetic interpretation of temperature, estimation of rms speeds of molecules, Equipartition of energy, specific heat of mono, di and tri-atomic gases, Adiabatic and isothermal expansion of an ideal gas.

Real Gas: Van der Waals gas, equation of state, nature of van der Waals forces, comparison with experimental P-V curves, The critical constants, Reduced equation of state.

Thermal conductivity and diffusivity, differential equation of rectilinear flow of heat (one dimension), Ingen-Hauz experiment.

Unit-2: (10 Lectures)

Laws of thermodynamics: The Zeroth law, first law of thermodynamics, Reversible and irreversible changes, Carnot cycle and its efficiency, Carnot theorem and the second law of thermodynamics, Entropy, principle of increase of entropy, The thermodynamic scale of temperature; its identity with the perfect gas scale, Impossibility of attaining the absolute zero; third law of thermodynamics.

Thermodynamic Relationships: Thermodynamics potentials, Maxwell's general relationships, clausius-clapeyron latent heat equation.

Unit-3: (10 Lectures)

Scalars and Vectors: dot and cross products, triple vector product, gradient, divergence and curl. Gauss's divergence theorem, Green's theorem and Stoke's theorem (Statements and applications only). Curvilinear co-ordinates: Transformation of co-ordinates, Orthogonal curvilinear co-ordinates, unit vectors in curvilinear co-ordinates, gradient, divergence and curl, cylindrical and spherical polar co-ordinates. Tensor analysis: Concept of tensor with examples, transformation of co-ordinate, summation convention, contravariant and covariant tensors, Kronecker delta, mixed tensor, symmetric and skew-symmetric tensors, rank of a tensor.

Unit-4: (10 Lectures)

Matrices: A review of matrix addition and multiplications, Transpose and conjugate transpose of a matrix, Adjoint and inverse of a matrix, Transpose and inverse of product of two matrices. Special matrices: Singular matrices, symmetric and skew symmetric matrices, Hermitian and skew Hermitian matrices, orthogonal and unitary matrices. Application of matrices: Rotation of co-ordinates exes, solution of linear algebraic equation by matrix methods, Rank of matrix. Characteristic equation: eigen values, eigen vectors, calculation of eigen values and eigen vectors of (2x2) matrices, properties of eigen values & eigen vectors of Hermitian & unitary matrices, Trace of a matrix, diagonalisation of symmetric (2x2) and (3x3) matrix with examples.

Unit-5: (10 Lectures)

Beta and Gamma functions: Definitions of beta and gamma function, Fundamental property of Gamma functions, The value of $\Gamma\left(\frac{1}{2}\right)$ and Graph of the Gamma function, Transformation of Gamma function, Different forms of Beta function, Relationship between Beta and Gamma functions. To show that $\beta(m,n) = \beta(n,m)$, $\beta(m,n) = \frac{\Gamma(m)\Gamma(n)}{\Gamma(m+n)}$, $\Gamma(m)\Gamma\left(m+\frac{1}{2}\right) = \frac{\sqrt{\pi}}{2^{2m-1}}\Gamma(2m)$. Applications of β and Γ functions.

Recommended Books:

1. M. N. Saha and B. N. Srivastava: *A Textbook on Heat*, The Indian Press, (latest edition)
2. P. K. Chakaraborty: *Advanced Text Book on Heat*, Modern Book Agency, Kolkata.
3. D. S. Mathur: *Fundamentals of Heat*, S. Chand & Co. (latest edition)
4. M. W. Zemannsky: *Heat and Thermodynamics*, Student Edition – McGraw Hill Book Co.
5. F.W. Sears: *Thermodynamics*, Addison-Wesley Publications.
6. H.K. Dass: *Mathematical Physics*, S. Chand & Co.
7. B D Gupta: *Mathematical Physics*, Vikash Publishing House (latest edition).
8. P.K.Chattopadhyay: *Mathematical Physics*, Wiley & Sons.
9. Mathews & Walker: *Mathematical Methods of Physics*, W.A. Benjamin, Inc. (latest edition)
10. M. R. Spiegel: *Vector Analysis & An Introduction to Tensor Analysis*, McGraw Hill.
11. F. A. Hinchey: *Vectors and Tensors*, Wiley Eastern

Second Semester
Laboratory-II
Course No: PHY/II/EC/02(P)

Marks Scale: 100 marks **Credit: 2**
(End Sem.: 75+ Int.: 25) **(0- 0- 2)**

One (1) experiment is to be performed within 3 hours in the End Semester examination. A minimum of 4 experiments is to be performed by the students.

1. Determine the coefficient of linear expansion of a rod by optical lever method.
2. Determine the specific heat of a liquid by the method of cooling.
3. Determine the pressure coefficient by using a constant volume thermometer.
4. Determine the coefficient of apparent expansion of a liquid by weight thermometer.
5. To determine horizontal component H and the magnetic moment M of a bar magnet with the help of a deflection and vibration magnetometer.
6. To determine the angle of dip at a place by dip circle.
7. Verification of inverse square law in magnetism.

Recommended Books:

1 K. G. Majumdar and B. Ghosh: *A Textbook of Practical Physics*, Vol-I&II, Sreedhar Publications, Kolkata.
2 H. Singh: *B.Sc. Practical Physics*, S. Chand & Co. Ltd. (latest edition)
3. C.L. Arora: *Practical Physics*, S. Chand & Co. Delhi.
- S. K. Ghosh: *A Textbook of Practical Physics*, New Central Book Agency, Kolkata

Note: *Experiments may be added or deleted subject to the availability of facilities in the College.*

Third Semester
Electromagnetism and Optics
Course No: PHY/III/EC/03(T)

Marks Scale: 100 marks **Credit: 4**

(End Sem.: 75+ Int.: 25) **(3- 1- 0)**

Unit-1: (10 Lectures)

Flux of the electric field: Gauss's law and its application for finding E for symmetric charge distributions, Fields at the surface of a conductor. Derivation of Poisson's and Laplace's equation.

Capacitors: electrostatic field energy, force per unit area on the surface of a conductor in an electric field, Dielectrics, Parallel plate capacitor with a dielectric, dielectric constant, polarization and polarization vector, displacement vector D.

Unit-2: (10 Lectures)

Electrical current: Current and Current density, continuity equations, Ohm's law and Kirchoff's laws.

Network theorem: Principles of Superposition, Voltage and current divider rules, Thevenin and Norton's theorems. Transient current: rise and decay of currents in LR and CR and LCR circuits, time constant.

Alternating currents: complex impedance, reactance, LCR series and parallel circuits, resonance, Q factor, power dissipation and power factor. AC bridges: Anderson and Owen's bridge.

Unit-3: (10 Lectures)

Force on a moving charge: Lorentz force equation, force on a straight conductor carrying current in a uniform magnetic field, torque on a current loop. Biot and Savart's law, calculation of H in simple geometrical situations, Ampere's law and its simple applications. Magnetic field due to a current loop, magnetic dipole moment.

Electromagnetic Induction: Faraday's laws (integral and differential form), Displacement current, Modified Ampere's law and its application.

Unit-4: (10 Lectures)

Interference of light: The principle of superpositions, Young's two-slit interference, Production of Interference by Fresnel biprism, determination of wavelength of light, theory of Newton's ring and its application.

Michelson interferometer, its application for precision determination of wavelength, wavelength difference and the width of spectral lines.

Polarization of light: production of polarized light by reflection and refraction.

Double refraction and optical rotation: Refraction in uni-axial crystals, Phase retardation plates, double image prism. Rotation of plane of polarization, origin of optical rotation in liquids and crystals, Brewster's law, optic axis of a crystal, Faraday effect.

Unit-5: (10 Lectures)

Fresnel diffraction: Fresnel half-period zones, zone-plates, straight edge.

Fraunhofer diffraction: Diffraction at a slit, half-period zones, phasor diagram, the intensity distribution, diffraction at a circular aperture, resolution of images, Rayleigh criterion, resolving powers of telescope and microscopic systems.

Diffraction gratings: Diffraction at N parallel slits, intensity distribution, plane diffraction grating. Resolving power of a grating and resolving powers of prism.

Recommended Books:

1. D.J.Griffiths: *Introduction to Electrodynamics*, 3rd Edition, PHI, New Delhi (2002).
2. Satya Prakash: *Electromagnetic Theory & Electrodynamics*, Pragati Prakashan.
3. D. Chattopadhyay and P.C. Rakshit: *Electricity & Magnetism*, Books and Allied (P) Ltd.

4. Reitz and Milford: *Electricity and Magnetism*, Addison-Wesley.
5. A. S. Mahajan and A. S. Rangwala: *Electricity and Magnetism*, Tata McGraw Hill
6. D. N. Vasudeva: *Electricity and Magnetism*, S. Chand & Co.
7. D. C. Tayal: *Electricity and Magnetism*, Himalaya Publishing House (latest edn.).
8. A. K. Ghatak: *Physical Optics*
9. D. P. Khandelwal: *Optics and Atomic Physics*, Himalaya Publishing House (1988).
10. K. D. Maller: *Optics*, Oxford University Press.
11. Jenkins and White: *Fundamentals of Optics*, McGraw-Hill.

Third Semester

Laboratory-III

Course No: PHY/III/EC/03(P)

Marks Scale: 100 marks **Credit: 2**
(End Sem.: 75+ Int.: 25) **(0- 0- 2)**

One (1) experiment is to be performed within 3 hours in the End Semester examination. A minimum of 4 experiments is to be performed by the students.

1. Determine the focal length of two convex lenses and their combination by displacement method.
2. Determine the magnifying power of a telescope.
3. To measure unknown resistance by using Post Office Box.
4. To determine the reduction factor of a tangent galvanometer and hence the value of H.
5. Determine the current and voltage in a given network and hence verify Kirchhoff's laws.
6. To determine the resistance of a lamp at room temperature and when incandescent.
7. Determine the resistance per unit length of a wire by Carey Foster's method.

Recommended Books:

1 K. G. Majumdar and B. Ghosh: *A Textbook of Practical Physics*, Vol-I&II, Sreedhar Publications, Kolkata.
2 H .Singh: *B.Sc. Practical Physics*, S. Chand & Co. Ltd. (latest edition)
3. C.L. Arora: *Practical Physics*, S. Chand & Co. Delhi.
4. S. K. Ghosh: *A Textbook of Practical Physics*, New Central Book Agency, Kolkata

Note: *Experiments may be added or deleted subject to the availability of facilities in the College*

Fourth Semester

Atomic, Nuclear Physics-I and Solid State Physics-I

Course No: PHY/IV/EC/04(T)

Marks Scale: 100 marks **Credit: 4**

(End Sem.: 75+ Int.: 25) **(3- 1- 0)**

Unit-1: (10 Lectures)

Positive rays: Thomson's parabola method, isotopes, isobars, Aston's mass spectrograph, Bainbridge mass spectrograph.

Atomic structure: Bohr's theory of H-like atoms, Pauli's exclusion principle, quantum number for atomic orbitals and degeneracy.

X-ray spectra: continuous spectra and its explanation (Duane- Hunt law), Characteristics X-ray spectra, energy level diagram, Moseley's law, and its importance, Compton scattering, deduction for change in wavelength, experimental verification.

Unit-2: (10 Lectures)

Radioactivity: Laws of radioactive disintegration, half-life, mean-life, decay constant. Properties of alpha, beta and gamma rays, Radio carbon dating.

General properties of Nucleus: Nuclear size, nuclear mass, nuclear density, nuclear charge, Binding energy, stability of nucleus and binding energy, packing fraction.

Nuclear fission: Discovery, energy released in fission, secondary neutrons and their importance, multiplication factor, chain reaction.

Nuclear fusion: origin of stellar energy, calculation of fusion energy.

Unit-3: (10 Lectures)

Crystal Structure: Periodicity of crystals, unit cells, primitive cells, fundamental translational vectors, symmetry operations: translation and point operators, symmetry groups, space groups, Fundamental types of lattices in 2 and 3-dimensions, Crystal planes, simple crystal structure: NaCl and Diamond structure, Miller indices, coordination numbers, atomic packing factor.

Unit-4: (10 Lectures)

X-Ray diffractions: X-ray diffraction by crystal planes, Bragg's law of diffraction, Laue's equations, Reciprocal Lattice and lattice vectors, properties of reciprocal lattice vectors, Relation between direct and reciprocal lattice vectors.

Bonding in Crystals: Concept of cohesive energy, Ionic, covalent, Van der Waal's and Metallic bonding, Madelung's constant of NaCl crystal.

Unit-5: (10 Lectures)

Thermal properties: Specific heat of solid, Deduction of Dulong and Petit law from the harmonic oscillator concept, Einstein's theory of specific heat and its failures, Debye T^3 law of specific heat.

Motion of electrons: Free electrons motion, conduction electrons, electron collisions, mean free path, relaxation time, current density and electrical conductivity formulae, Thermal conductivity, Weidmann-Franz law, Fermi energy, Fermi velocity, Energy levels and density of states in one and three dimensions.

Recommended Books:

1. H.S. Mani and G.K. Mehta: *Introduction to Modern Physics*, Affiliated East-West Press,
2. A. Beiser: *Perspective of Modern Physics*, McGraw Hill.
3. H.E. White: *Introduction to Atomic Physics*, McGraw Hill.
4. C. Kittel: *Introduction to Solid State Physics*, 8th Edition, John Wiley and Sons.
5. M.A. Omar: *Elementary Solid State Physics*, Pearson Edn. (2004).
6. Arun Kumar: *Introduction to Solid State Physics*, PHI India Ltd.

7. S.O. Pillai: *Solid State Physics*, New Age International, (2001).
8. B. N. Srivastava: *Basic Nuclear Physics & Cosmic Rays*, Pragati Prakashan (1992)
9. S. N. Ghosal: *Nuclear Physics*, S. Chand & Co. (2006)
10. W.E. Burcham and M. Jobbs: *Nuclear and Particle Physics*, Addison Wesley (1998)

Fourth Semester

Laboratory-IV

Course No: PHY/IV/EC/04(P)

Marks Scale: 100 marks **Credit: 2**
(End Sem.: 75+ Int.: 25) **(0- 0- 2)**

One (1) experiment is to be performed within 3 hours in the End Semester examination. A minimum of 4 experiments is to be performed by the students.

1. Draw the characteristics curves of semiconductor diode.
2. To study the characteristics of a Zener diode
3. To determine the energy gap of a Semiconductor diode.
4. To study the various Transistor biasing configurations.
5. Study the static characteristics of a transistor in CE/CB configuration
6. Determine the ECE of copper by using a potentiometer
7. Study the dynamic characteristics of a transistor in CE/CB configuration

Recommended Books:

1. K. G. Majumdar and B. Ghosh: *A Textbook of Practical Physics*, Vol-I&II, Sreedhar Publications, Kolkata.
2. H. Singh: *B.Sc. Practical Physics*, S. Chand & Co. Ltd. (latest edition)
3. C.L. Arora: *Practical Physics*, S. Chand & Co., Delhi.
4. S. K. Ghosh: *A Textbook of Practical Physics*, New Central Book Agency, Kolkata
5. K K Dey & B N Dutta: *Practical Physics*, Kalyani Publishers (latest edition)

Note: *Experiments may be added or deleted subject to the availability of facilities in the College.*

Fifth Semester

Mathematical Physics-II

Course No: PHY/V/CC/05(T)

Marks Scale: 100 marks **Credit: 4**
(End Sem.: 75+ Int.: 25) **(3- 1- 0)**

Unit-1: (10 Lectures)

Complex variables: Functions of a complex variable, Cauchy-Riemann conditions, Taylor series and Laurent series (both without proof), poles and residue, Cauchy's residue theorem with proof, application of residue theorem in integrals of functions having simple poles, Cauchy integral theorem and formula, singularities and their classification, the residue theorem, evaluations of integrals using residue theorem.

Unit-2: (10 Lectures)

Ordinary differential equations: Meaning of ordinary point, Power series solution of ordinary differential equation, Frobenius method.

Partial differential equation: solution of partial differential equations by the method of separation of variables, application of this method in solving the (i) differential equation of heat flow in one dimension (ii) equation of a vibrating string and (iii) Laplace's equation in two dimension (Cartesian and Polar coordinates).

Unit-3: (10 Lectures)

Legendre Polynomial: solution of Legendre differential equation, Legendre polynomials $P_n(x)$, Rodrigue formula for $P_n(x)$ generating function $P_n(x)$ and recurrence relations, orthogonal property of $P_n(x)$.

Bessel functions: solution of Bessel's differential equation, Bessel function $J_n(x)$.

Generating function of $J_n(x)$, Recurrence relation of $J_n(x)$, Integrals of $J_0(x)$ and $J_n(x)$.

Hermite Polynomials: solutions of Hermite differential equation, Generating functions, recurrence relations, orthogonal property of $H_n(x)$.

Unit-4: (10 Lectures)

Fourier Series: expansion of a function of in a series of sines and cosines of multiple of Fourier series for the interval $(-\pi, \pi)$, $(0, \pi)$ and $(0, 2\pi)$, Fourier series for half wave and full wave rectifier, complex representation of a Fourier series.

Fourier integrals: Fourier integral, its different forms and its application to solve integrals.

Fourier Transforms: Finite Fourier Transforms, Fourier sine and cosine transform, properties of a fourier transform, derivative of a transform, transform of the derivative, Inverse Fourier transform and its properties, application of Fourier transforms to boundary value problems.

Dirac Delta function: definition and properties, Fourier transform of delta function.

Unit-5: (10 Lectures)

Laplace transform: Definition, properties of Laplace transforms, methods of finding Laplace transform., Laplace transforms of some special functions, evaluation of integrals with Laplace transforms, Inverse Laplace transform, evaluation of integrals with Laplace and inverse Laplace transforms, Application of Laplace transforms to differential equation, boundary value problems.

Recommended Books:

1. B.D. Gupta: *Mathematical Physics*, Vikas Publishing House.
2. RK Gupta and HC Sharma: *Mathematical Physics*, Meenakshi Prakashan.
3. H.K. Dass: *Mathematical Physics*, S. Chand & Co. (latest edition)
4. Satya Prakash: *Mathematical Physics*, S. Chand & Co. (1996).
5. G. B. Arfken and H.J. Weber: *Mathematical Methods for Physicists*, Academic Press, 6^{th} Ed.
6. P.K.Chattopadhyay: *Mathematical Physics*, Wiley & Sons.
7. Mathews & Walker: *Mathematical Methods of Physics*, W.A. Benjamin, Inc. (latest edition

Fifth Semester

Electronics–I

Course No: PHY/V/CC/06(T)

Marks Scale: 100 marks **Credit: 4**
(End Sem.: 75+ Int.: 25) **(3- 1- 0)**

Unit-1: (10 Lectures)

P and N type semiconductors. Energy level diagram. Conductivity and mobility, concept of drift velocity, Hall Effect, Hall Coefficient. pn junction diode, barrier formation in PN junction. Derivation of Barrier Potential, Width and current for abrupt junction. Current flow mechanism in forward and reverse biased diode.

Unit-2: (10 Lectures)

Rectifier diode: Half wave rectifiers, Centre-tapped and Bridge Full-Wave Rectifiers, Calculation of Ripple Factor and Rectification Efficiency, L, C and π-filters, Zener diode and voltage regulation. Principle, structure and characteristics of LED, Photodiode and Solar Cell, Qualitative idea of Schottky diode and Tunnel diode.

Unit – 3: (10 lectures)

p-n-p and n-p-n transistors, characteristics of CB, and CE configurations. Active, Cutoff and Saturation Regions. Current gains α and β. Relations between α and β. Load Line analysis of transistors. DC Load line and Q point. Physical mechanism of current flow. Transistor biasing and stabilization circuits, voltage divider bias. Transistor as 2-port Network. H-parameter equivalent circuit. Analysis of a single stage CE amplifier using Hybrid model. Input and output impedance. Classification of Class A, B and C amplifier.

Unit-4: (10 Lectures)

RC – coupled amplifier and its frequency response, Feedback in amplifiers; positive and negative feedback, effect of negative feedback on input impedance, output impedance, gain, stability, distortion and noise. Sinusoidal oscillators; Barkhausen's criterion for self-sustained oscillations. Colpitt's oscillator, Hartley Oscillator, Phase shift oscillator.

Unit – 5: (10 Lectures)

Basic characteristics of Op-Amp without detailed internal circuit of IC; characteristics of ideal op-amp, open loop and close loop gain, inverting and noninverting amplifier, summer, differentiator, integrator. Logic gates, AND, OR, NOT, NAND, NOR, XOR gates, truth tables, combination of gates, De-Morgan's theorem, Simplification of Logic Circuit using Boolean Algebra, Binary Number System, conversion of binary into decimal and vice versa, Binary addition and subtraction (only 2's complement method), fundamental products, conversion of truth table into equivalent logic circuit.

Recommended Books:

1.A. Malvino: *Electronics Principles*,3rd Edition (1984), Tata McGraw Hill Edition, New Delhi.
2.Malvino and Leach: *Digital Principles & Application*.
3.V. K. Mehta: *Principles of Electronics*, S. Chand and Company.
4.S.M. Sze: *Semiconductor Physics*,.
5.D. C. Tayal: *Basic Electronics*, Himalaya Publishing House.
6.R. A. Gaykwad: *Op-Amps and Linear Integrated Circuits*, Prentice Hall of India, 2002.
7.Gupta and Kumar: *Handbook of Electronics*, S. Chand.&Co.

Fifth Semester

Classical Mechanics and Nuclear Physics-II

Course No: PHY/V/CC/07(T)

Marks Scale: 100 marks **Credit: 4**
(End Sem.: 75+ Int.: 25) **(3- 1- 0)**

Unit-1: (10 Lectures)

Centre of mass and its equation of motion, Reduction of two body problem to one body problem, reduced mass, Motion under a central force, Kepler's law, Deduction of Newton's laws of gravitation from Kepler's laws of planetary motion and Kepler's laws form Newton's laws.

Constraints and generalized co-ordinates, Principle of virtual work, D'Alembert's principle, Lagrangian and Lagrange's equations for simple problems, Keplerian motion. Hamilton's canonical equation from Lagrange's equation, Hamilton's equation of motion for simple problems.

Unit-2: (10 Lectures)

General properties of nucleus: classification of nuclei, isotopes, isobars, isotones, isomers and mirror nuclei. Nuclear charge, mass, size, spin, magnetic moments, electrical quadrupole moment.

Concept of binding energy and packing fraction, binding energy curve and its significance, Semi-empirical mass formula and its simple application, neutron-proton ratio in stable nuclei, stability curve, odd even rules of nuclear stability.

Alpha decay: cause of alpha decay, basic α-decay process, range and energy of α-decay, alpha particle disintegration energy, Geiger-Nuttal law.

β-decay: Types of β-decays, conditions of β_+ & β- decay and K capture, β-ray spectrum, γ-rays and their origin, Measurements of gamma ray energies by crystal spectrometer.

Unit-3: (10 Lectures)

Nuclear models and nuclear reaction: Liquid drop model and shell model.

Artificial transmutation: Artificial transmutation, scheme of nuclear reactions, Conservation laws, calculation of Q values, threshold energy, cross-section of nuclear reactions, discovery of neutron, properties of neutron, determination of mass of neutron, classification of neutrons according to their kinetic energy.

Nuclear fission: Energy released in fission, secondary neutrons and their importance, chain reaction, concept of critical size, four factor formula, enriched uranium, Uranium-graphite nuclear reactor.

Nuclear fusion: p-p and C-N cycle, calculation of fusion energy.

Unit-4: (10 Lectures)

Particle accelerator: Need for particle accelerator, electrostatic accelerators, linear accelerators, cyclotron, betatron, electron synchrotron, proton synchrotron, accelerators in India.

Particle detectors: Interaction of charged particles and neutrons with matter, working of gas filled nuclear detectors. Ionisation chamber and Wilson cloud chamber, GM counter,

Proportional counter, bubble chamber, spark chamber, scintillation counter, semiconductor counters, Cerenkov counter, Neutron Counters.

Unit-5: (10 Lectures)

Cosmic rays and elementary particles: Intensity of cosmic rays on earth's surface, latitude effect, east-west effect, altitude effect, primary cosmic rays, secondary cosmic rays, origin of cosmic rays, absorption showers, extensive air showers, fundamentals of theory of electron showers (Bhabha's theory), Discovery of positron, muon, pion, Ideas of leptons, baryons and mesons, concept of anti-particles, Universal conservation laws- statements and their application to production and decay of mesons and baryons, Discovery of strange particles, isospin, strangeness, hypercharge, elementary particles symmetries, quarks and quark hypothesis, basic interactions of quarks and leptons.

Recommended Books:

1.J.C. Upadhyaya: *Classical Mechanics*, Himalaya Publishing House, 5th Edition.
2.Rana and Joag,: *Classical Mechanics*, Tata McGraw Hill
3.Suresh Chandra: *Classical Mechanics*, Narosa Pub. House (2009).
4.D. C. Tayal: *Nuclear Physics*, Himalaya Publishing House (1991)
5.B. N. Srivastava: *Basic Nuclear Physics & Cosmic Rays*, Pragati Prakashan (1992)
6.S. N. Ghosal: *Nuclear Physics*, S. Chand & Co. (2006)
7.A. E. S. Green: *Nuclear Physics*, McGraw Hill Book Co., (Latest Edn, Student Ed.)
8.W.E. Burcham and M. Jobbs: *Nuclear and Particle Physics*, Addison Wesley (1998)
9.Irving Kaplan: *Nuclear Physics*, 2nd Ed., Narosa Publishing House (2002).
10.D.J. Griffiths: *Introduction to Elementary Particles*, John Wiley & Sons (1987).

Fifth Semester

Laboratory-V

Course No: PHY/V/CC/05(P)

Marks Scale: 100 marks **Credit: 3**
(End Sem.: 75+ Int.: 25) **(0- 0- 3)**

One (1) experiment is to be performed within 3 hours in the End Semester examination. A minimum of 5 experiments is to be performed by the students.

1. Use CRO for the study of A.C. supply waveform and compare the frequencies.
2. To study a CE amplifier of a given gain (mid-gain) using Voltage divider bias.
3. Determine the value of mechanical equivalent of heat by Joule's electrical calorimeter.
4. Determine the thermal conductivity of a metallic rod by Searle's method.
5. Verification of Stefan's law.
6. Draw the B-H curve of an iron sample.
7. Draw the plateau of a GM counter and carry out the statistical analysis.
8. Determine the self and mutual inductances of a given coil by Carey-Foster's method.

Recommended Books:

1. K. G. Majumdar and B. Ghosh: *A Textbook of Practical Physics*, Vol-I&II, Sreedhar Publications, Kolkata.
2. H. Singh: *B.Sc. Practical Physics*, S. Chand & Co. Ltd. (latest edition)
3. C.L. Arora: *Practical Physics*, S. Chand & Co., Delhi.
4. S. K. Ghosh: *A Textbook of Practical Physics*, New Central Book Agency, Kolkata
5. K K Dey & B N Dutta: *Practical Physics*, Kalyani Publishers (latest edition)

Note: *Experiments may be added or deleted subject to the availability of facilities in the College.*

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Fifth Semester

Laboratory-VI

Course No: PHY/V/CC/06(P)

Marks Scale: 100 marks **Credit: 3**
(End Sem.: 75+ Int.: 25) **(0- 0- 3)**

One (1) experiment is to be performed within 3 hours in the End Semester examination. A minimum of 5 experiments is to be performed by the students.

1. Determine the thermal conductivity of a bad conductor by Lee's method.
2. Determine the Stefan's constant
3. To determine the coefficient of viscosity of a liquid by rotating viscometer.
4. To determine the value of g by Kater's pendulum.
5. Determine the modulus of rigidity of a cylindrical body by statical method
6. Determination of wavelength of laser light using ruler/diffraction grating.
7. Determination of the diameter of a thin wire using laser.
8. Determine the radius of curvature of a convex lens by Newton's rings method

Recommended Books:

1 K. G. Majumdar and B. Ghosh: *A Textbook of Practical Physics*, Vol-I&II, Sreedhar Publications, Kolkata.
2 H. Singh: *B.Sc. Practical Physics*, S. Chand & Co. Ltd. (latest edition)
3. C.L. Arora: *Practical Physics*, S. Chand & Co., Delhi.
4. S. K. Ghosh: *A Textbook of Practical Physics*, New Central Book Agency, Kolkata.

Note: *Experiments may be added or deleted subject to the availability of facilities in the College*.

Fifth Semester

Laboratory-VII

Course No: PHY/V/CC/07(P)

Marks Scale: 100 marks **Credit: 2**
(End Sem.: 75+ Int.: 25) **(0- 0- 2)**

1. Determine the wavelength of monochromatic light by Michelson's interferometer.
2. Measure the width of a single slit from the study of its Fraunhoffer diffraction.
3. Determine the wavelength of sodium D-lines by using Fresnel biprism.
4. Determination of wavelength of laser light using ruler/diffraction grating.
5. Determination of the diameter of a thin wire using laser.
6. Determine the radius of curvature of a convex lens by Newton's rings method

Recommended Books:

1 K. G. Majumdar and B. Ghosh: *A Textbook of Practical Physics*, Vol-I&II, Sreedhar Publications, Kolkata.
2 H. Singh: *B.Sc. Practical Physics*, S. Chand & Co. Ltd. (latest edition)
3. C.L. Arora: *Practical Physics*, S. Chand & Co., Delhi.
4. S. K. Ghosh: *A Textbook of Practical Physics*, New Central Book Agency, Kolkata.

Note: *Experiments may be added or deleted subject to the availability of facilities in the College*.

Fifth Semester
Optional Paper I (*any one*)
Atomic and Molecular Spectroscopy
Course No: PHY/V/CC/08(a)(T)

Marks Scale: 100 marks **Credit: 4**
(End Sem.: 75+ Int.: 25) **(3- 1- 0)**

Unit-1: (10 Lectures)

Rutherford's alpha particle scattering experiment, derivation of Rutherford's cross section formula, Rutherford atom model and its failure, Bohr atomic model, total energy, hydrogen spectral series, fine structure, shortcomings of Bohr's theory, Sommerfeld's elliptical orbits, radial and azimuthal quantum numbers, total energy, Sommerfeld's relativistic correction, fine structure, fine structure of H-line, shortcomings of Sommerfeld's model.

Unit-2: (10 Lectures)

Vector atom model, spatial quantisation and electron spin, spin-orbit interaction, Stern and Gerlach experiment, quantum numbers n,l,s,j,m_l,m_s,m_j and their physical interpretation, magnetic moments of an atom, and Lande's factor, Larmor's theorem, Coupling scheme for non-equivalent electrons and selection rules.

Pauli's exclusion principle, maximum number of electrons in a given group or subgroup, periodic table, Doublet fine structure of hydrogen and alkali atoms.

Unit-3: (10 Lectures)

Zeeman effect: classical interpretation of normal Zeeman effect, normal and anomalous Zeeman effect for one electron system, Paschen-Back effect, Stark effect - linear and quadratic (qualitative idea).

X-rays: Concept of fine structure of X-rays levels, X-ray fluorescent and the Auger effect.

Lasers: Einsteins's A and B coefficients derivative (in detail), population inversion, pumping schemes, properties of laser light, Rate equation for three level systems.

Unit-4: (10 Lectures)

Born Oppenheimer approximation (general idea), Pure rotational spectra, rigid rotator, energy levels, frequency of spectral line, selection rule and the spectrum, Non-rigid rotator, energy levels, spectrum, determination of inter-molecular distance (HCl, CO, N_2) Vibrating diatomic molecule as a harmonic oscillator, frequency, energy levels, selection rules, spectrum, coupling of rotation and vibration, molecule as anharmonic oscillator, energy levels, transition rules, spectrum, application of vibrational spectroscopy.

Unit-5: (10 Lectures)

Electronic configurations and states of homonuclear diatomic molecules, Electronic band systems, Sequences and progressions in emission and absorption, Frank Condon principal energy levels, selection rules, rotational fine structure of vibrational transitions, P, Q, R branches.

Fortrat diagram, Raman effect and its semi-quantum mechanical explanation, fundamentals of vibrational Raman spectra, comparison of infrared and Raman scattering.

Recommended Books:

1. H. S. Mani and G K Mehta: *Introduction to Modern Physics*, Affiliated East-West Press.
2. Gupta, Kumar and Sharma: *Elements of Spectroscopy*, Pragati Prakashan.
3. G. M. Barrow: *Molecular Spectroscopy*, McGraw Hill Book Co.
4. H. Barrow: *Theory of Atomic Spectra*
5. Harvey E. White, *Introduction to Atomic Spectra,* McGraw Hill Book Co.
6. G. Aruldhass: *Modern Physics*, PHI India Ltd.
7. E. Murugeshan: Modern Physics, S. Chand & Co.

Fifth Semester
Optional Paper I (*any one*)

C-Language and Numerical Methods

Course No: PHY/V/CC/08(b)(T)

Marks Scale: 100 marks **Credit: 4**
(End Sem.: 75+ Int.: 25) **(3- 1- 0)**

Unit-1: (10 Lectures)

Basic structure of C programs: Character set, C tokens, keywords and identifiers, constants, variables, data types, declaration of variables, assigning value to variable, defining symbolic constants.

Operators and Expression: Operators-arithmetic, relational, logical, assignment, increment-decrement, conditional, bit-wise and special. Arithmetic expressions, evaluation of expressions, precedence of arithmetic operators, type conversions in expressions, operator precedence and associativity.

Unit-2: (10 Lectures)

Managing Input and Output Operators: Formatted input/output-more about printf() and scanf() functions. Unformatted input – getchar(), getch(), getche(), gets(). Unformatted output – putchar (), puts ().

Functions: Definition, prototype of a function, standard library functions, User-Defined Functions, Need for user-defined functions, return values and their types, category of functions: no arguments and no return values, arguments but no return values, arguments with return values. Handling of non-integer functions, calling a function-call by value and call by reference.

Unit-3: (10 Lectures)

Decision making or control statements: If, If-Else, nested If-Else, Switch-Case statements; looping statements: entry controlled and exit controlled statements—While, For, Do-While; Break, Continue and Goto statements.

Arrays: Definition, declaration and initialization: One-dimensional arrays, two-dimensional arrays. Multi-dimensional arrays. Sorting: Bubble and insertion sort. Linear search.

Pointers: Definition, accessing the address of variable, declaring and initializing pointers, accessing a variable through its pointer, pointers and arrays, arrays of pointers, pointers and functions.

Unit-4: (10 Lectures)

Approximate numbers and significant figures: Absolute and relative errors, General formula for error, Application of the error formula, Successive approximation, Taylor's series, Principle of least square, least square fitting. Interpolation: Linear, Lagrange's and Newton's, Gregory-Newton's difference interpolation. Solution of algebraic and transcendental equations by Iteration method, Bisection method and Newton-Raphson method.

Unit-5: (10 Lectures)

Numerical solutions: Numerical differentiation- differentiation by Lagrange's interpolation, differentiation by Newton's interpolation, Gregory-Newton interpolation, Numerical integration- Simpson's rule, Trapezoidal Rule, Gauss's quadrature formula.

Recommended Books:

1. E. Balagurusamy: *Programming in ANSI C*, Tata McGraw Hill Publications.
2. Ashok N.Kamthane: *Programming with ANSI and Turbo C*, Pearson Education
3. B. Kernigan and D. Ritchie : *The ANSI C Programming Language*, PHI Publications.
4. Byron Gotterfried : *Programming with ANSI C*, Tata McGraw Hill Publications
5. V. Rajaraman: *Computer Oriented Numerical Methods*, Prentice Hall (2003).

6. V. Rajaraman: *Computer Programming in C*, PHI (2005).
7. C. Xavier: *C Language and Numerical Methods*, New Age Intl. Ltd. (2004).
8. Suresh Chandra: *Computer Application in Physics*, Narosa Pub. House, New Delhi.

Fifth Semester

Laboratory-VIII

Course No: PHY/V/CC/08(P)

Marks Scale: 100 marks **Credit: 2**
(End Sem.: 75+ Int.: 25) **(0- 0- 2)**

One (1) experiment is to be performed within 3 hours in the End Semester examination. A minimum of 4 experiments is to be performed by the students.

1. Write a C++ program to solve a Quadratic Equation.
2. Write a C++ program to calculate matrix addition.
3. Write a C++ program to calculate matrix multiplication.
4. Write a C++ program for differentiation of a function.
5. Write a C++ program for integration of a function.
6. Write a C++ program for solving an algebraic equation by Newton-Raphson method.
7. Write a C++ program for solving an algebraic equation by Bisection method.

Recommended Books

1. V. Rajaraman: *Computer Programming in C*, PHI (2005).
2. C. Xavier: *C Language and Numerical Methods*, New Age Intl. Ltd. (2004).
3. E. Balagurusamy: *Programming in ANSI C*, Tata McGraw Hill Publications.
4. B. Kernigan and D. Ritchie: *The ANSI C Programming Language*, PHI Publications.

Note: *Experiments may be added or deleted subject to the availability of facilities in the College.*

Sixth Semester

Quantum Mechanics

Course No: PHY/VI/CC/09(T)

Marks Scale: 100 marks **Credit: 4**
(End Sem.: 75+ Int.: 25) **(3- 1- 0)**

Unit-1: (10 Lectures)

Origin of the quantum theory: Failure of classical physics to explain the phenomena such as black-body spectrum, Ritz combination principle in spectra, Stability of an atom, Planck's radiation law (qualitative idea only). Photoelectric effect, Compton Effect, De Broglie hypothesis, wave particle duality, Davisson-Germer experiment, Phase and Group velocities, wave packets, two slit experiment with electrons, probability, wave amplitude and wave functions, Heisenberg's uncertainty relation for p and x, its extension to energy and time.

Unit-2: (10 Lectures)

Quantum mechanics: Basic postulates and formalism, Schrodingers' equation, Schrodinger equation as eigen value equation, eigen value and eigen function, probabilistic interpretation, time dependent and time independent Schrodinger equation.

Schrodinger's equation to solve one dimensional problems, particle in a box, particle in a finite well, boundary conditions, normalized wavefunction, bound states, reflection and transmission by a finite potential step, quantum phenomenon of tunneling.

Unit – 3: (10 Lectures)

Operator method in quantum mechanics: Linear operators, commutator, matrix representation of linear operators, eigen values and eigen functions, eigen vectors of operators, Hermitian operators and its properties, Adjoint operators.

Linear simple harmonic oscillator, energy eigenvalues and wavefunction, zero point energy. Particle in a three dimensional cubical box, degeneracy. Spherically symmetric systems and potentials, orbital ngular momentum and azimuthal quantum numbers, physical significance. Hydrogen atom problem, solution of Schrodinger's equation in spherical polar coordinates, azimuthal, polar and radial wave equations, energy levels and degeneracy.

Unit-4: (10 Lectures)

Angular momentum operators L^2 and L_z and their eigen values and eigen functions, Spatial quantization, Angular momentum and magnetic moment of electron due to orbital motion; Bohr magneton, Stern-Gehrlach experiment, Uhlenbeck and Goudsmit's hypothesis of electron spin; Pauli's method of spin variable, Eigenvalues and eigenfunctions of the spin operator, Pauli spin operators and commutation relations.

Unit-5 (10 Lectures)

Infinite dimensional vector space - Hilbert space (basic ideas only), definition of a linear vector space (LVS), Linear combinations, Linear dependence and independence, inner product of two vectors, concept of basis sets, orthonormal basis sets, Gram-Schmidt orthonormalization, expansion of an arbitrary vector, matrix representation of vector, Dirac's bra-ket notation

Recommended Books:

1. Arthur Beiser: *Modern Physics*, McGraw Hill Company.
2. H.S. Mani, G. K. Mehta: *Introduction to Modern Physics*, Tata McGraw Hill Company, New Delhi.
3.E. Merzbacher: *Quantum Mechanics*, 3rd Ed., John Wiley & Sons, 1998.
4.J. J. Sakurai: *Modern Quantum Mechanics*, Pearson Education, 2002.
5.R. Shankar: Principle of Quantum Mechanics, 2nd Ed., Springer, 2008.

Sixth Semester

Electromagnetic Theory

Course No: PHY/VI/CC/10(T)

Marks Scale: 100 marks **Credit: 4**
(End Sem.: 75+ Int.: 75) **(3- 1- 0)**

Unit-1: (10 Lectures)

Faraday's law for electromagnetic induction, Faraday's law in integral and differential forms; energy stored in an inductor and in the magnetic field. Displacement current; modified Ampere's law, Maxwell's equations with their derivations, Maxwell's equations in vacuum, and in material media, boundary conditions.

Unit-2: (10 Lectures)

Maxwell's equations in vacuum, and in material media, boundary conditions.

Electromagnetic waves in free space - wave equation satisfied by E and B in free space and its solution, transverse nature of e.m. wave and its orthogonality, ratio of amplitudes of E and B, energy density of e.m. wave, Poynting vector and Poynting theorem, energy per unit volume, momentum of e.m. wave, radiation pressure.

Unit-3: (10 Lectures)

Propagation of electromagnetic wave in dielectric medium, reflection and refraction at normal incidence and oblique incidence at dielectric boundary, Polarization of e.m. wave - Brewster angle, Total internal reflection, Propagation of electromagnetic wave in conducting medium, skin depth, reflection and refraction at conducting boundary,

Unit-4: (10 Lectures)

Magnetic and Scalar potential, – their non uniqueness, Lorentz and Coulomb gauge transformations, Poisson's equation using vector potential in terms of current density, Laplace equation using scalar potential in terms of charge density, magnetic dipole using magnetic scalar potential, Lorentz force law using e.m. potentials, momentum using e.m. potentials.

Unit – 5: (10 Lectures)

Classical Theory: Properties of thermal radiation, Kirchhoff's law, Stefan-Boltzmann law and Wien's displacement law.

Quantum theory: Planck's law of black body radiation, deduction of Wien's radiation formula, Rayleight-Jeans law, Stefan- Boltzmann law and Wien's displacement law from Planck's law. Laser Working principle, thermal equilibrium of radiation, principle of detailed balance, Eisnteins A and B coefficients, population inversion, two level and three level systems.

Recommended Books:

1.D.J. Griffiths: *Introduction to Electrodynamics*, 3rd Edition, PHI, New Delhi (2002

2.J. D. Jackson, Classical Electrodynamics, 3rd Ed., John Wiley, 2005.

3. B. B. Laud: Laser and Non-linear Optics,Second Edition, New Age International (Pvt.) Ltd., New Delhi, 2005.

4. K. Thyagarajan, A. K. Ghatak: *Lasers: Theory and Applications*, McMillan India Ltd., 1981.

Sixth Semester

Thermal and Statistical Physics

Course No: PHY/VI/CC/11(T)

Marks Scale: 100 marks **Credit: 4**

(End Sem.: 75+ Int.: 25) **(3- 1- 0)**

Unit-1: (10 Lectures)

Kinetic Theory of Matter: Evidences of kinetic theory of matter, Brownian motion, Einstein's theory of translational Brownian motion, Verification by Perrin and determination of

Avogadro's number, law of equipartition of energy- deduction of the law by the method of momentoids.

Deduction of Maxwell-Boltzmann law of distribution of velocity of molecules, experimental verification by Stern, deduction of velocity (average), r.m.s velocity, most probable velocity and energy distribution law, Mean free path, deduction of the expression, collision, probability, law of distribution of free path, experimental verification by Born's experiment.

Unit-2: (10 Lectures)

Non-equilibrium of gases: transport phenomena in gases, viscocity, thermal conductivity, diffusion (elementary deduction), their dependence on pressure and temperature.

Thermodynamical relations: Thermodynamical energy functions- internal energy functions, enthalpy, Helmholtz function, Gibb's function, Derivation of Maxwell's relations from thermodynamical energy functions, Application variation of intrinsic energy with volume, Tds equation, difference of C_P and C_v (all thermodynamical relations), to deduce ($C_P - C_v$) relations for perfect and real gases, variation of C_v with volume and C_P with pressure, Gibb's phase rule, its deduction and application to mono, di component systems, triple point.

Unit-3: (10 Lectures)

The statistical basis of thermodynamics: Probability and thermodynamic probability; principle of equal a priori probabilities, Accessible and inaccessible states, Phase space representation: phase cells of arbitrary size, one- dimensional oscillator, free particles, the function ϕ(E) and Ω(E), definition of probability, average properties of the system in equilibrium state.

Thermal equilibrium between two systems, beta parameter and its identity with $(kT)^{-1}$, probability and entropy, Boltzmann entropy relation, statistical interpretation of the second law of thermodynamics, Boltzmann canonical distribution law.

Unit-4: (10 Lectures)

Ensembles: Canonical, Micro-canonical, Grand canonical ensemble. Stirling's approximation, probability distribution in canonical ensemble, Thermodynamic quantities in canonical ensembles-internal energy, entropy and free energy, energy distribution in canonical ensemble. probability distribution in grand canonical ensemble, Thermodynamic quantities in grand canonical ensembles- mean particle number, entropy and grand potential.

Unit-5: (10 Lectures)

Maxwellian distribution of speeds in an ideal gas: Derivation of the distribution of speed, specific heat and internal energy using MB statistics, Application of MB statistics.

Quantum statistics: Cases of particles in a box and simple harmonic oscillator, Setting phase-cell size as nature's constant (Planck's constant h), quantization of energy, Indistinguishability of particles, effect of absolute entropy, Bose-Einstein and Fermi-Dirac statistics, free electron metals and photon in a blackbody chamber. Fermi level and Fermi energy, its variation with temperatures.

Recommended Books:

1. M. N. Saha and B. N. Srivastava: *A Textbook on Heat*, The Indian Press, (latest edition)
2. P. K. Chakaraborty: *Advanced Text Book on Heat*, Modern Book Agency, Kolkata.
3. D. S. Mathur: *Fundamentals of Heat*, S. Chand & Co. (latest edition)
4. M. W. Zemannsky: *Heat and Thermodynamics*, Student Edition – McGraw Hill Ltd.
5. F.W. Sears: *Thermodynamics,* Addison-Wesley Publications.
6. B. Laud: *Fundamentals of Statistical Mechanics*, New Age Intl. Ltd. (1998)
7. K Huang, *Statistical Mechanics* (2nd Ed) John Wiley & Sons (2002).

8. Brij Lal and N. Subrahmanyam: *Heat and Thermodynamics*, S.Chand & Co. Ltd.
9. S. K. Roy: *Thermal Physics*, New Age International (P) Ltd.
10. S. Lokanathan & R.S. Gambhir: *Statistical Mechanics & Thermal Physics*, PHI (2007

Sixth Semester

Laboratory-IX

Course No: PHY/VI/CC/09(P)

Marks Scale: 100 marks **Credit: 2**
(End Sem.: 75+ Int.: 75) **(0- 0- 2)**

One (1) experiment is to be performed within 3 hours in the End Semester examination. A minimum of 4 experiments is to be performed by the students.

1. Determine the value of e/m of electron (any method).
2. Determine the number of lines per unit length of the grating by using a spectrometer.
3. Determine the refractive index of the material of a prism at different wavelengths by using a spectrometer.
4. Determine the figure of merit of a galvanometer.
5. Calibration of an ammeter and a voltmeter by using a potentiometer.
6. Determine the melting point of a wax using a Thermocouple.

Recommended Books:

1. K. G. Majumdar and B. Ghosh: *A Textbook of Practical Physics*, Vol-I&II Sreedhar Publications, Kolkata.
2. H. Singh: *B.Sc. Practical Physics*, S. Chand & Co. Ltd. (latest edition)
3. C.L. Arora: *Practical Physics*, S. Chand & Co. Delhi.
4. S.K. Ghosh: *A Textbook of Practical Physics*, New Central Book Agency, Kolkata

Note: *Experiments may be added or deleted subject to the availability of facilities in the College.*

Sixth Semester

Laboratory-X

Course No: PHY/VI/CC/10(P)

Marks Scale: 100 marks **Credit: 2**
(End Sem.: 75+ Int.: 25) **(0- 0- 2)**

One (1) experiment is to be performed within 3 hours in the End Semester examination. A minimum of 4 experiments is to be performed by the students.

1. Determine the electrolytic conductivity of a substance by Kohlrausch's method
2. To study the Frequency Response and Voltage Gain of a RC-Coupled Amplifier.
3. Study the Hall effect and determine the Hall coefficient and Hall voltage.
4. Measure the capacitance by de Sauty's method
5. Determine the self inductance of a coil by Raleigh's method using a Wheatstone bridge.
6. Determine the work function and Plank's constant by using a photocell.
7. Study the series and parallel resonance circuits with A.C. source and draw the current frequency curve and calculate Q.

Recommended Books:

1. K. G. Majumdar and B. Ghosh: *A Textbook of Practical Physics*, Vol-I&II Sreedhar Publications, Kolkata.
2. H. Singh: *B.Sc. Practical Physics*, S. Chand & Co. Ltd. (latest edition)
3. C.L. Arora: *Practical Physics*, S. Chand & Co. Delhi.
4. S.K. Ghosh: *A Textbook of Practical Physics*, New Central Book Agency, Kolkata

Note: *Experiments may be added or deleted subject to the availability of facilities in the College*.

Sixth Semester

Laboratory-XI

Course No: PHY/VI/CC/11(P)

Marks Scale: 100 marks **Credit: 2**
(End Sem.: 75+ Int.: 25) **(0- 0- 2)**

One (1) experiment is to be performed within 3 hours in the End Semester examination. A minimum of 4 experiments is to be performed by the students.

1. To verify and AND, OR, NOT and XOR gates using NAND gates
2. Study of OP-AMP characteristics
3. OP-AMP as a) Adder and Subtractor b) Differentiator and Integrator.
4. Study of Half Adder, Full Adder and 4 bit Binary Adder.
5. Study of Half Subtractor, Full Subtractor, Adder, Subtractor using Full Adder
6. Study of a simple power circuit with a pi-section filter.

Recommended Books:

1. K. G. Majumdar and B. Ghosh: *A Textbook of Practical Physics*, Vol-I&II Sreedhar Publications, Kolkata.
2. H. Singh: *B.Sc. Practical Physics*, S. Chand & Co. Ltd. (latest edition)
3. C.L. Arora: *Practical Physics*, S. Chand & Co. Delhi.
4. S.K. Ghosh: *A Textbook of Practical Physics*, New Central Book Agency, Kolkata

Note: *Experiments may be added or deleted subject to the availability of facilities in the College.*

Sixth Semester
Optional Paper II (*any one*)
Solid State Physics – II
Course No: PHY/VI/CC/12(a)(T)

Marks Scale: 100 marks **Credit: 4**
(End Sem.: 75+ Int.: 25) **(3- 1- 0)**

Unit-1: (10 Lectures)

Lattice vibrations : Elastic vibrations in a continuous media, Phase and Group velocities of elastic waves, Vibrations of one-dimensional monoatomic and diatomic chain of linear atoms, Dispersion relations, Acoustic and Optical modes of vibrations, concept of Brillouin zones and phonons.

Unit-2: (10 Lectures)

Dia-, Para-, Ferri- and Ferromagnetic Materials. Classical Langevin Theory of dia – and paramagnetic Domains, Quantum Mechanical Treatment of Paramagnetism, Curie's law, Weiss's Theory of Ferromagnetism and Ferromagnetic Domains, Discussion of B-H Curve, Hysteresis and Energy Loss.

Unit-3: (10 Lectures)

Polarization, Local Electric Field at an Atom, Depolarization Field. Dielectric Constant, Electric Susceptibility, Polarizability, Classical Theory of Electric Polarizability, Clausius-Mosotti Equation, Normal and Anomalous Dispersion, Complex Dielectric Constant.

Unit-4: (10 Lectures)

Band Theory of Solids, Bloch Theorem, Kronig-Penney Model, Origin of energy bands and Band Gaps, Effective Mass of Electron, Concept of Holes, Energy band diagrams of Si, Ge, Cu and W (discussions only), Classification of Solids in terms of energy bands. Direct and Indirect transitions and Band Gaps in Ge.

Unit-5: (10 Lectures)

Superconductivity, Critical Temperature, Critical magnetic field, Meissner effect, Type I and Type II Superconductors, London's equation and Penetration depth, Isotope effect, BCS theory (no derivation): Cooper Pair and Coherence length, Variation of Superconducting Energy Gap with Temperature.

Recommended Books :

1. C. Kittel: *Introduction to Solid State Physics*, 8th Edn., John Wiley & Sons (1999)
2. H.P. Myers: *Introduction to Solid State Physics*, 2nd Edn, Viva Books(P) Ltd. (1998)
3. A.J. Dekker: *Solid State Physics*, Macmillan India Ltd. (1986.)
4. J.P. Srivastava: *Elements of Solid State Physics*, PHI (2001)
5. H. Ibach and H. Luth: *Solid State Physics*, 2nd Edition, Springer (1996)
6. R.E. Hummel: *Electronic Properties of Materials*, 3rd Edition, Springer (2001)
7. N.W. Ashcroft & N.D. Mermin: *Solid State Physics*, Hault & Saunders (1981)
8. M.S. Rogalski & S.B. Palmer: *Solid State Physics*, 1st Edn., Gordon and Breach
9. M. Ali Omar: *Elementary Solid State Physics: Principles and Applications*, Pearson Education (1999)
10. Arun Kumar: *Introduction to Solid State Physics*, PHI India Ltd.

Sixth Semester

Optional Paper II (*any one*)

Electronics – II

Course No: PHY/VI/CC/12(b)(T)

Marks Scale: 100 marks **Credit: 4**
(End Sem.: 75+ Int.: 25) **(3- 1- 0)**

Unit-1: (10 Lectures)

Kirchhoff's Laws, Norton's and Thevenin's theorems and their applications in circuit analysis (numerical problems included), relationship between Thevenin's and Norton's equivalent circuit. Hybrid parameters, determination of h-parameters, h parameter equivalent circuit, performance of a linear circuit in h-parameters, h parameters of a transistor and its nomenclature, input impedance, current gain and voltage gain of transistor in h-parameters.

Unit-2: (10 Lectures)
Half and Full Adders. Half and Full Subtractors, 4-bit binary Adder/ Subtractor. SR, D, and JK Flip-Flops. Clocked (Level and Edge triggered) Flip-Flops, Preset and Clear operations. Race-around conditions in JK Flip-Flop, M/S JK Flip-Flop. IC 555: block diagram and applications: Astable and Monostable multivibrators.

Unit 3: (10 lectures)
Shift registers: Serial-in-Serial-out, parallel-in-serial-out and paraller-in-parallel-out shift registers (only up to 4 bits). Counters (4-bits): Ring Counter, Asynchronous counters, decade counter. Synchronous counter.
Computer Organization: Input/ Output Devices. Data storage (idea of Ram and ROM). Computer Memory. Memory organization and addressing.

Unit-4: (10 Lectures)
Introduction to CRO: Block diagram of CRO. Electron gun, deflection system and time base. Applications of CRO: (1) Study of waveform, (2) measurement of voltage, current, frequency and phase difference.
Integrated circuits: Active and passive components. Discrete components. Wafer. Chip. Advantages and drawbacks of ICs. Scale of integration: SSI, MSI, LSI and VLSI (basic idea and definitions only). Classification of ICs. Difference between Analog and Digital Circuits.
Unit 5: (10 lectures)
Block diagram of electronic communication system. Need for modulation. Amplitude modulation. Analysis of Amplitude Modulated wave. Sideband frequencies in AM wave. CE Amplitude modulator. Demodulation of AM wave using diode detector. Basic idea of frequency and phase modulation.

Recommended Books:

1. Robert Boylestad, Louis Nashelsky: Electronic Devices and Circuit Theory, 8th Edn, Pearson Education, India (2004).
2. A. P. Malvino: Electronic Principles, Glencoe (1993).
3. John Morris: Analog Electronics.
4. Allen Mottershead: Electronic Circuits and Devices, PHI (1997).
5. Ben G. Streetman & Sanjay Banerjee: Solid State Electronic Devices, Pearson Prentice Hall (2006).
6. N. N. Bhargava, D. C. Kulshreshtha & SC Gupta : Basic Electronics & Linear Circuits, Tata McGrawHill (2006).
7. Handbook of Electronics, Gupta and Kumar, S. Chand.
8. Digital Principle & Application, Malvino and Leech.

Sixth Semester

Laboratory-XII/Project

Course No: PHY/VI/CC/12(P)

Marks Scale: 100 marks **Credit: 2**
(End Sem.: 75+ Int.: 25) **(0- 0- 2)**

One (1) experiment is to be performed within 3 hours in the End Semester examination. A minimum of 4 experiments is to be performed by the students.

1. Write a FORTRAN program to solve a Quadratic Equation.
2. Write a FORTRAN program to find roots of f(x)=0 by using bisection method.
3. Find the sum of a (i) Cosine series (ii) Sine series by using FORTRAN program.
4. Write a FORTRAN program for (i) Matrix Addition and (ii) Matrix Multiplication and compare results with analytical treatment
5. Write a FORTRAN program to find roots of f(x)=0 by using Newton-Raphson method.
6. Write a FORTRAN program to integrate the given function by Simpson's 1/3 rule.
7. Write a FORTRAN program for differentiation of a given function.

Recommended Books:

1. K. G. Majumdar and B. Ghosh: *A Textbook of Practical Physics*, Vol-I&II, Sreedhar Publications, Kolkata.
2. H. Singh: *B.Sc. Practical Physics*, S. Chand & Co. Ltd. (latest edition)
3. C.L. Arora: *Practical Physics*, S. Chand & Co. Delhi.
4. S. K. Ghosh: *A Textbook of Practical Physics*, New Central Book Agency, Kolkata.
5. S.S. Srivastava and M.Gupta: *Experiments in Electronics*, S. Chand & Co.
6. Indu Prakash & Ramkrishna: *A Textbook of Practical Physics*, Kitab Mahal.

OR

Project work based on Physics/Electronics to be assigned/ supervised by teachers, which is to be completed before End Semester examination.

Recommended Books:

1. C.L.Arora: *B.Sc. Practical Physics*, S. Chand &Co.
2. H.Singh: *B.Sc. Practical Physics*, S. Chand &Co.
3. S.S. Srivastava and M.Gupta: *Experiments in Electronics*, S. Chand & Co.,Delhi
4. College Laboratory Manuals and Semiconductor Manuals.