Ch. Ranbir Singh University, Jind

Scheme and Syllabus of Examination for Undergraduate programme

Subject: PHYSICS

Under Multiple Entry-Exit, Internships and
CBCS-LOCF in accordance to NEP 2020
w.e.f. 2023-24 (in phased manner)

Semester	Course Type	Course Code	Nomenclature of paper	Credits	Contact hours	Internal marks	End term Marks	Total Marks	Duration of exam (Hrs) T + P
1	CC-1/ MCC-1	B23-PHY-101	Mechanics	3	3	20	50	70	3
			Practicum	1	2	10	20	30	3
	MCC-2	B23-PHY-102	Mathematical Physics	3	3	20	50	70	3
			Practicum	1	2	10	20	30	3
	CC-M1	B23-PHY-103	Elementary Mechanics	1	1	10	20	30	3
			Practicum	1	2	5	15	20	3
	MDC 1	B23-PHY-104	Physics Fundamentals-I	2	2	15	35	75	3
			Practicum	1	2	5	20	25	3
2	CC-2 MCC-3	B23-PHY-201	Electricity and Magnetism& EM Theory	3	3	20	50	70	3
			Practicum	1	2	10	20	30	3
	CC-M2	B23-PHY-202	Elementary Electricity, Magnetism & EM Theory	1	1	10	20	30	3
			Practicum	1	2	5	15	20	3
	DSEC-1	B23-PHY-203	Computational Physics	3	3	20	50	70	3
			Practicum	1	2	10	20	30	3
	MDC- 2	B23-PHY-204	Physics Fundamentals-II	2	2	15	35	50	3
			Practicum	1	2	5	20	25	3

3	CC-3/ MCC-4	B23-PHY-301	Thermodynamics & Statistical Physics	3	3	20	50	70	3
			Practicum	1	2	10	20	30	3
	CC-M3	B23-PHY-302	Thermodynamics	3	3	20	50	70	3
			Practicum	1	2	10	20	30	3
	MCC-2- (Scheme- B)	B23-PHY-102	Mathematical Physics	3	3	20	50	70	3
			Practicum	1	2	10	20	30	3
	MCC-5	B23-PHY-303	Classical Mechanics	3	3	20	50	70	3
			Practicum	1	2	10	20	30	3
	MDC 3	B23-PHY-304	Elements of Modern Physics	2	2	15	35	50	3
			Practicum	1	2	5	20	25	3
4	CC-4/ MCC-6	B23-PHY-401	Waves and Optics	3	3	20	50	70	3
			Practicum	1	2	10	20	30	3
	MCC-7	B23-PHY-402	Introductory Quantum Mechanics	3	3	20	50	70	3
			Practicum	1	2	10	20	30	3
	MCC-8	B23-PHY-403	Atomic Spectroscopy	3	3	20	50	70	3
			Practicum	1	2	10	20	30	3
	DSE-1	B23-PHY-404	Laser Physics and Fiber Optics	3	3	20	50	70	3
			Practicum	1	2	10	20	30	3
		OR							
		B23-PHY-405	Physics of Nano Materials	3	3	20	50	70	3
			Practicum	1	2	10	20	30	3
5	CC-5 MCC-9	B23-PHY-501	Modern Physics	3	3	20	50	70	3
			Practicum	1	2	10	20	30	3

	MCC-10	B23-PHY-502	Nuclear Physics	3	3	20	50	70	3
			Practicum	1	2	10	20	30	3

	DSE-2	B23-PHY-503	Environmental Physics	3	3	20	50	70	3
			Practicum	1	2	10	20	30	3
		OR							
		B23-PHY-504	Non-Linear Dynamics	3	3	20	50	70	3
			Practicum	1	2	10	20	30	3
	DSE-3	B23-PHY-505	Instrumentation and Analytical Methods	3	3	20	50	70	3
			Practicum	1	2	10	20	30	3
		OR							
		B23-PHY-506	Renewable Energy and Energy Harvesting	3	3	20	50	70	3
			Practicum	1	2	10	20	30	3
6	CC-6 MCC-11	B23-PHY-601	Electronics	3	3	20	50	70	3
			Practicum	1	2	10	20	30	3
	MCC-12	B23-PHY-602	Solid State Physics-1	3	3	20	50	70	3
			Practicum	1	2	10	20	30	3
	DSE-4	B23-PHY-603	Condensed Matter Physics-1	3	3	20	50	70	3
			Practicum	1	2	10	20	30	3
		OR							
		B23-PHY-604	Material Science	3	3	20	50	70	3
			Practicum	1	2	10	20	30	3
	DSE-5	B23-PHY-605	Nuclear and Particle Physics	3	3	20	50	70	3
			Practicum	1	2	10	20	30	3
		OR							

		B23-PHY-606	Modern Characterization Techniques	3	3	20	50	70	3
			Practicum	1	2	10	20	30	3

7	CC-H1	B23-PHY-701	Advanced Mathematical Physics	4	4	30	70	100	3
	CC-H2	B23-PHY-702	Statistical Mechanics	4	4	30	70	100	3
	CC-H3	B23-PHY-703	Quantum Mechanics	4	4	30	70	100	3
	DSE-6	B23-PHY-704	Molecular Physics	4	4	30	70	100	3
		OR							
		B23-PHY-705	Sensors and Transducers	4	4	30	70	100	3
	PC-H1	B23-PHY-706	Practicum Course	4	8	30	70	100	6
8	CC-H4	B23-PHY-801	Electrodynamics and Plasma Physics	4	4	30	70	100	3
	CC-H5	B23-PHY-802	Advance Quantum Mechanics	4	4	30	70	100	3
	CC-H6	B23-PHY-803	Digital Electronics	4	4	30	70	100	3
	DSE-7	B23-PHY-804	Solid State Physics-II	4	4	30	70	100	3
		OR							
		B23-PHY-805	Condensed Matter Physics-II	4	4	30	70	100	3
	PC-H2	B23-PHY-806	Practicum Course	4	8	30	70	100	6
	Research	B23-PHY-R-807	Project/ Dissertation	12			300	300	

Scheme of Examination for VAC

Semester	Course Type	Course Code	Nomenclature of paper	Credits	Contact hours	Internal marks	End term Marks	Total Marks	Duration of exam (Hrs) T / P
3	VAC-3	PHY-VAC-316	Indian Astronomy in the 18^{th} and 19^{th} Centuries	2	2	15	35	50	3
3	VAC-3	PHY -VAC-318	Basics of Indian Astronomy	2	2	15	35	50	3
3	VAC-3	PHY -VAC-326	Exploring the Journey of Indian Space Satellites	2	2	15	35	50	3
4	VAC-4	PHY -VAC-419	Physics in Everyday Life	2	2	15	35	50	3
4	VAC-4	PHY -VAC-423	Radiation Hazards	2	2	15	35	50	3

Ch. Ranbir Singh University, Jind
Undergraduate Programs
Course: CC-1/MCC-1

Session: 2023-24			
Part A - Introduction			
Subject	Physics		
Semester	1st		
Name of the Course	Mechanics		
Course Code	B23-PHY-101		
Course Type: (CC/MCC/MDC/CC-M/ DSEC /VOC/DSE/PC/AEC/VAC)	CC/MCC		
Level of the course (As per Annexure-I	100-199		
Pre-requisite for the course (if any)	Physics as main subject at level 4 (i.e. 10+2 or equivalent)		
Course Learning Outcomes(CLO):	After completing this course, the learner will be able to: 1. Understand the dynamics of system of particles, conservation of energy and momentum application of both translational and rotational dynamics motions simultaneously in analyzing rolling with slipping. 2. Differentiate between elastic and plastic body. Elastic constants, determination and their physical significance. Torque and its significance. 3. Familiar about the special theory of relativity and its applications. Michelson's Morley experiments and its finding. 4. Analyze the two body Central Force problem and its applications 5. Learn to present observations, results, analysis and different concepts related to experiments of Mechanics.		
Credits	Theory	Practical	Total
	3	1	4
Contact Hours	3	2	5
Max. Marks:100 **Internal Assessment Marks:30** **End Term Exam Marks: 70**		**Time:3hrs**	

Part B- Contents of the Course

Instructions for Paper- Setter

1.Nine questions will be set in total.

2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.

3. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.

4. 20% numerical problems are to be set.

5. Use of scientific (non-programmable) calculator is allowed.

Unit	Topics	Contact Hours
I	**Fundamentals of Dynamics**: Rigid body, Moment of Inertia, Radius of Gyration, Theorems of perpendicular and parallel axis (with proof), Moment of Inertia of ring, Disc, Angular Disc, Solid cylinder, Solid sphere, Hollow sphere, Rectangular plate, Square plate, Solid cone, Triangular plate, Torque, Rotational Kinetic Energy, Angular momentum, Law of conservation of angular momentum, Rolling motion, condition for pure rolling, acceleration of body rolling down an inclined plane, Fly wheel, Moment of Inertia of an irregular body.	11
II	**Elasticity:** Deforming force, Elastic limit, stress, strain and their types, Hooks law, Module of elasticity Relation between shear angle and angle of twist, elastic energy stored/volume in an elastic body, Elongation produced in heavy rod due to its own weight and elastic potential energy stored in it, Poisson's ratio and its limiting value, Relation between Young modulus, Bulk modulus and Poisson ratio. Derive the Relation between Young's modulus, Bulk modulus and Modulus of rigidity. Torque required for twisting cylinder, Bending of beam, bending moment and its magnitude, Bending of cantilever (loaded by a weight W at its free end), weight of cantilever uniformly distributed over its entire length. Dispersion of a centrally loaded beam supported at its ends, determination of elastic constants for material of wire by Searle's method.	11
III	**Special Theory of Relativity:** Michelson's Morley experiments and its outcome, Postulate of special theory of relativity, Lorentz Transformation, Simultaneity and order of events, Lorentz contraction, Time dilation, Relativistic transformation of velocity, relativistic addition of velocities, variation of mass-energy equivalence, relativistic Doppler effect.	10
IV	**Gravitation and central force motion:** Law of gravitation, Potential and field due to spherical shell and solid sphere. Motion of a particle under central force filed, Two body problem and its reduction to one body problem and its solution, determination of g by means of bar pendulum, Normal coordinates and normal modes, Normal modes of vibration for given spring mass system, possible angular frequencies of oscillation of two identical simple pendulums of length (l) and small bob of mass (m) joined together with spring of spring constant (k.)	11

	Practicum 1. Measurement of length (or diameter) using vernier caliper, screw gauge and travelling microscope. 2. To study the random error in observations. 3. To determine the area of window using a sextant. 4. Moment of Inertia of a Fly Wheel 5. Moment of Inertia of irregular body using a Torsion Pendulum. 6. Young Modulus by Bending of Beam. 7. Modulus of rigidity of material of wire by Maxwell's Needle. 8. Elastic constant by Searle's method. 9. To determine the value of 'g' by using Bar pendulum. 10. To find the Poisson ratio of rubber. 11. To compare Moment of Inertia of a solid Sphere, Hollow Sphere and solid Disc of same mass with the help of Torsion Pendulum. 12. To determine the bending moment of a cantilever beam with uniformly distributed load, uniformly varying load and point load. **Note: Student will perform at least five experiments. The examiner will allot one practical at the time of end term examination.**	30

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory (20 Marks)** • Class Participation: **05 Marks** • Seminar/presentation/assignment/quiz/class test etc.: **05 Marks** • Mid-Term Exam: **10 Marks** ➢ **Practicum (10 Marks)** • Class Participation: **Nil** • Seminar/Demonstration/Viva-voce/Lab records etc.: **10 Marks** • Mid-Term Exam: **Nil**	**End Term Examination : 50 Marks** **: 20 Marks**

Part C-Learning Resources

Recommended Books/e-resources/LMS

1. Mechanics "Berkeley Physics Course Vol. I", Charles Kittel, Tata McGraw-Hill
2. Mechanics, D.S. Mathur, S. Chand and Company Limited, 2000
3. Elements of Properties of Matter, D.S. Mathur, S .Chand & Com. Pt. Ltd., New Delhi
4. Physics, Resnick, Halliday & Walker, Wiley
5. Physics for scientists and Engineers with Modern Phys., J.W. Jewett, R.A. Serway, 2010, Cengage Learning
6. An introduction to mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw-Hill.
7. Properties of Matter, R. Murgeshan, S. Chand & Com. Pt. Ltd., New Delhi
8. Classical Mechanics, J.C. Upadhyaya, Himalaya Publishing House.
9. B.Sc. Practical Physics, C.L. Arora, S. Chand Publisher, New Delhi
10. Advanced Level Practical Physics, M. Nelkon and Ogborn, Henemann Education Books Ltd., New Delhi
11. Practical Physics, S.S. Srivastava and M.K. Gupta, Atma Ram & Sons, Delhi
12. Practical Physics, S.L. Gupta and V. Kumar, Pragati Prakashan Meerut
13. Modern Approach to Practical Physics, R.K. Singla, Modern Publishers, Jalandhar
14. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, Asia Publishing House.

Ch. Ranbir Singh University, Jind
Undergraduate Programs
Course: MCC-2

<table>
<tr><th colspan="4">Session: 2023-24</th></tr>
<tr><th colspan="4">Part A - Introduction</th></tr>
<tr><td>Subject</td><td colspan="3">Physics</td></tr>
<tr><td>Semester</td><td colspan="3">1st</td></tr>
<tr><td>Name of the Course</td><td colspan="3">Mathematical Physics</td></tr>
<tr><td>Course Code</td><td colspan="3">B23-PHY-102</td></tr>
<tr><td>Course Type: (CC/MCC/MDC/CC-M/ DSEC /VOC/DSE/PC/AEC/VAC)</td><td colspan="3">MCC</td></tr>
<tr><td>Level of the course (As per Annexure-I</td><td colspan="3">100-199</td></tr>
<tr><td>Pre-requisite for the course (if any)</td><td colspan="3">Physics as main subject at level 4 (i.e. 10+2 or equivalent)</td></tr>
<tr><td>Course Learning Outcomes(CLO):</td><td colspan="3">After completing this course, the learner will be able to:
1. Learn the Fourier analysis of periodic functions and their applications in physical problems. Learn the beta, gamma and the error functions and their applications in doing integrations.
2. Acquire knowledge of methods to solve partial differential equations with the examples of important partial differential equations in Physics.
3. Write given function in terms of sine and cosine terms in Fourier series and also to get knowledge in Fourier transforms
4. Learn about beta gamma function, their properties, solve Legendre equations find generating function for Legendre Polynomial and sole Hermite equation and study orthogonal properties of Hermite Polynomials and recurrence relations of complex numbers and their properties such as analyticity, poles and residues.
5. Learn about the methods to solve the mathematical problem using Fortran</td></tr>
<tr><td rowspan="2">Credits</td><td>Theory</td><td>Practical</td><td>Total</td></tr>
<tr><td>3</td><td>1</td><td>4</td></tr>
<tr><td>Contact Hours</td><td>3</td><td>2</td><td>5</td></tr>
</table>

Max. Marks:100 **Internal Assessment Marks:30** **End Term Exam Marks: 70**	**Time:3hrs**

Part B- Contents of the Course

Instructions for Paper- Setter

1.Nine questions will be set in total.

2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.

3. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.

4. 20% numerical problems are to be set.

5. Use of scientific (non-programmable) calculator is allowed.

Unit	Topics	Contact Hours
I	**Theory of Errors:** Systematic and Random errors, Propagation of errors, Normal law of errors, Standard and Probable error, Least square fit, error on slope and intercept of fitted line. **Matrices:** Normal Matrices, Orthogonal Matrices, Hermitian Matrices, Unitary Matrices, Symmetric and Anti-symmetric Matrices, Conjugate of a Matrix, Anti-hermitian Matrices, Trace of Matrix, Eigen values and eigen vectors of Matrices, Diagonalization of Matrices.	11
II	**Method of expansion of a function:** Taylor's expansion, Power series, Laurent's theorem. Partial and ordinary differential equations, Partial Differential equations, First order differential equations, Method of separation of variables, Singular points, Vibrations of a elastic string, One dimensional Heat Flow, Heat conduction equation for a 3-dimensional rectangular configuration and apply it to the cooling of a brick (assuming constant initial temperature distribution), vibrations of an elastic string, vibrations of rectangular and circular membrane, Power series, Method of Frobenius, Diffusion equation, Laplace's equation in problems of rectangular , cylindrical and spherical symmetry.	12
III	**Fourier series and Integrals:** Introduction, Evaluation of coefficients of Fourier series, cosine series, sine series, Dirichlet's theorem, Graphic; representation of Even and odd functions, Extension of interval, complex form of Fourier series, Properties of Fourier series: Convergence, Integration, Differentiation, Parseval's theorem, Physical applications of Fourier series analysis, square wave, Half wave rectifier, Full wave rectifier, A sawtooth wave, A triangular wave, Fourier Integrals, Starting with the Fourier series, deduction of expressions for the Fourier Transform and its inverse.	11
IV	**Beta, Gamma, Legendre and Hermite Functions:** Definition of gamma function, value of (1/2), Beta function, other forms of beta function, Relationship between beta and gamma function, Legendre's equation, Legendre's Polynomial, General solution of Legendre's equation, Generating function of Legendre's polynomial, orthogonality of Legendre's	11

	polynomials, Deduction of Rodrigue's formula for the Legendre's Polynomials, Hermite Polynomial, Hermite differential equation, Generating function of Hermite Polynomial.	
	Practicum **Review of FORTRAN Programming fundamentals:** FORTRAN Preliminaries: Integer and floating point arithmetic expression, built in functions, executable and non-executable statements, input and output statements, Formats, IF, DO, FOR and GO TO statements, Dimension arrays, statement function and function subprogram. To print out all natural (even/odd) numbers between given limits using computer. 1. Compute the product of two matrices of different dimension using DO loop 2. Numerical integration by Simpson 1/3 rule 3. Fitting of a straight line using Least-Square method 4. Using array variable, find out the average and standard deviation 5. Write a program to evaluate the function $Y=1 / [C (1 + e \cos \theta)]$ and $V=\sqrt{ [C M G (e2 + e \cos \theta + 1)]}$ e = 1.1, C = 3.0(E+08), M = 5.893(E+24), G = 6.67(E-11) for varying value of θ from 0 to π. 6. To find maximum, minimum and range of a given set of numbers using computer. 7. To evaluate sum of finite series. 8. Find the roots of a quadratic equation. 9. To find integration of a definite integral by trapezoidal rule. 10. To find the area of a triangle, sphere and cylinder. 11. Given values for a, b, c and d and a set of values for the variable x evaluate the function defined by. $f(x) = ax^2 + bx + c$ if $x < d$ $f(x) = 0$ if $x = d$ $f(x) = ax^2 + bx - c$ if $x > d$ For each value of x and print the value of x and f(x). Write a program for an arbitrary number of x values. **Note: Teachers have to give the review of FORTRAN Programming fundamentals to the students. Thereafter student will perform at least five experiments. The examiner will allot one practical at the time of end term examination.**	30

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory (20 Marks)** • Class Participation: **05 Marks** • Seminar/presentation/assignment/quiz/class test etc.: **05 Marks** • Mid-Term Exam: **10 Marks** ➢ **Practicum (10 Marks)** • Class Participation: **Nil** • Seminar/Demonstration/Viva-voce/Lab records etc.: **10 Marks** • Mid-Term Exam: **Nil**	**End Term Examination : 50 Marks** **20 Marks**

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Mathematical Methods for Physicists: Arfken, Weber, 2005, Harris, Elsevier
2. Fourier Analysis by M.R. Spiegel, 2004, Tata McGraw-Hill.
3. Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole.
4. An Introduction to Ordinary Differential Equations, Earl A Coddington, 1961, PHI Learning.
5. Differential Equations, George F. Simmons, 2006, Tata McGraw-Hill.
6. Essential Mathematical Methods, K.F. Riley and M.P. Hobson, 2011, Cambridge University Press
7. Partial Differential Equations for Scientists and Engineers, S.J. Farlow, 1993, Dover Publications.
8. Mathematical methods for Scientists and Engineers, D.A. McQuarrie, 2003, Viva Books.
9. Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House
10. Advanced level Physics Practical's, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
11. A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Edn, 2011, Kitab Mahal
12. Engineering Practical Physics, S. Panigrahi & B.Mallick, 2015, Cengage Learning India Pvt. Ltd.
13. Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University Press.
14. A Laboratory Manual of Physics for undergraduate classes, D.P. Khandelwal, 1985, Vani Pub.
15. Introduction to Numerical Analysis, S.S. Sastry, 5th Edn. , 2012, PHI Learning Pvt. Ltd.
16. Schaum's Outline of Programming with C++. J. Hubbard, 2000, McGraw-Hill Pub.
17. Numerical Recipes in C: The Art of Scientific Computing, W.H. Pressetal, 3rd Edn. , 2007, Cambridge University Press.
18. A first course in Numerical Methods, U.M. Ascher & C. Greif, 2012, PHI Learning.
19. Elementary Numerical Analysis, K.E. Atkinson, 3rd Edn . , 2007 , Wiley India Edition.
20. Numerical Methods for Scientists & Engineers, R.W. Hamming, 1973, Courier Dover Pub.
21. An Introduction to Computational Physics, T.Pang, 2 nd Edn. , 2006,Cambridge Univ. Press
22. Computational Physics, Darren Walker, 1 st Edn., 2015, Scientific International Pvt. Ltd.

Ch. Ranbir Singh University, Jind
Undergraduate Programs
Course: CC-M1

Session: 2023-24			
Part A - Introduction			
Subject	Physics		
Semester	1st		
Name of the Course	Elementary Mechanics		
Course Code	B23-PHY-103		
Course Type: (CC/MCC/MDC/CC-M/ DSEC /VOC/DSE/PC/AEC/VAC)	CC-M		
Level of the course (As per Annexure-I	100-199		
Pre-requisite for the course (if any)	Physics as main subject at level 4 (i.e. 10+2 or equivalent) and Physics not as major subject in 1st sem		
Course Learning Outcomes(CLO):	After completing this course, the learner will be able to: 1. Understand the dynamics of system of particles, Determination of moment of inertia using Theorems of parallel and perpendicular axis. Application of both translational and rotational dynamics motions simultaneously in analyzing rolling with slipping 2. Differentiate between elastic and plastic body. Elastic constants, determination and their physical significance. Torque and its significance in rotatory motion 3. Familiar about the special theory of relativity and its applications. Michelson's Morley experiments and its finding 4. Analyze the two body Central Force problem and its applications 5. Learn to present observations, results, analysis and different concepts related to experiments of Mechanics		
Credits	Theory	Practical	Total
	1	1	2
Contact Hours	1	2	3

Max. Marks:50 **Internal Assessment Marks:15** **End Term Exam Marks: 35**	**Time:3hrs**

Part B- Contents of the Course

Instructions for Paper- Setter

1.Nine questions will be set in total.

2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.

3. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.

4. 20% numerical problems are to be set.

5. Use of scientific (non-programmable) calculator is allowed.

Unit	Topics	Contact Hours
I	**Fundamentals of Dynamics**: Rigid body, Moment of Inertia, Radius of Gyration, Theorems of perpendicular and parallel axis (with proof), Moment of Inertia of ring, Disc, Angular Disc, Solid cylinder.	3
II	**Elasticity:** Deforming force, Elastic limit, stress, strain and their types, Hooks law, Module of elasticity Relation between shear angle and angle of twist, Poisson's ratio and its limiting value. Torque required for twisting cylinder.	4
III	**Special Theory of Relativity:** Michelson's Morley experiments and its outcome, Postulate of special theory of relativity, Lorentz Transformation, Lorentz contraction, Time dilation, Relativistic transformation of velocity, relativistic addition of velocities, variation of mass-energy equivalence	4
IV	**Gravitation and central force motion:** Law of gravitation, Potential and field due to spherical shell and solid sphere. Motion of a particle under central force filed, Normal coordinates and normal modes, Normal modes of vibration for given spring mass system, possible angular frequencies of oscillation of two identical simple pendulums of length (l) and small bob of mass (m0 joined together with spring of spring constant (k).	4
	Practicum 1. Measurement of length (or diameter) using vernier caliper, screw gauge and travelling microscope. 2. To study the random error in observations. 3. To determine the area of window using a sextant. 4. Moment of Inertia of a Fly Wheel 5. Moment of Inertia of irregular body using a Torsion Pendulum. 6. Young Modulus by Bending of Beam. 7. Young's modulus by Koenig's method. 8. Modulus of rigidity of material of wire by Maxwell's Needle. 9. Elastic constant by Searle's method. 10. To determine the value of 'g' by using Bar pendulum.	15

	Note: Student will perform at least five experiments. The examiner will allot one practical at the time of end term examination.	
Suggested Evaluation Methods		
Internal Assessment: ➢ **Theory (10 Marks)** • Class Participation: **04 Marks** • Seminar/presentation/assignment/quiz/class test etc.: **Nil** • Mid-Term Exam: **6 Marks** ➢ **Practicum (5 Marks)** • Class Participation: **Nil** • Seminar/Demonstration/Viva-voce/Lab records etc.: **5 Marks** • Mid-Term Exam: **Nil**		**End Term Examination : 20 Marks** **15 Marks**
Part C-Learning Resources		
Recommended Books/e-resources/LMS: **1.** Mechanics "Berkeley Physics Course Vol. I", Charles Kittel, Tata McGraw-Hill **2.** Mechanics, D.S. Mathur, S. Chand and Company Limited, 2000 **3.** Elements of Properties of Matter, D.S. Mathur, S .Chand & Com. Pt. Ltd., New Delhi **4.** Physics, Resnick, Halliday & Walker, Wiley **5.** Physics for scientists and Engineers with Modern Phys., J.W. Jewett, R.A. Serway, 2010, Cengage Learning **6.** An introduction to mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw-Hill. **7.** Properties of Matter, R. Murgeshan, S. Chand & Com. Pt. Ltd., New Delhi **8.** Classical Mechanics, J.C. Upadhyaya, Himalaya Publishing House **9.** B.Sc. Practical Physics, C.L. Arora, S. Chand Publisher, New Delhi **10.** Advanced Level Practical Physics, M. Nelkon and Ogborn, Henemann Education Books Ltd., New Delhi **11.** Practical Physics, S.S. Srivastava and M.K. Gupta, Atma Ram & Sons, Delhi **12.** Practical Physics, S.L. Gupta and V. Kumar, Pragati Prakashan Meerut **13.** Modern Approach to Practical Physics, R.K. Singla, Modern Publishers, Jalandhar **14.** Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, Asia Publishing House.		

Ch. Ranbir Singh University, Jind
Undergraduate Programs
Course: MDC-1

<table>
<tr><td colspan="4">Session: 2023-24</td></tr>
<tr><td colspan="4">Part A - Introduction</td></tr>
<tr><td>Subject</td><td colspan="3">Physics</td></tr>
<tr><td>Semester</td><td colspan="3">1st</td></tr>
<tr><td>Name of the Course</td><td colspan="3">Physics Fundamentals –I</td></tr>
<tr><td>Course Code</td><td colspan="3">B23-PHY-104</td></tr>
<tr><td>Course Type: (CC/MCC/MDC/CC-M/ DSEC /VOC/DSE/PC/AEC/VAC)</td><td colspan="3">MDC</td></tr>
<tr><td>Level of the course (As per Annexure-I</td><td colspan="3">100-199</td></tr>
<tr><td>Pre-requisite for the course (if any)</td><td colspan="3">Not studied Physics subject at level 4 (i.e. 10+2 or equivalent)</td></tr>
<tr><td>Course Learning Outcomes(CLO):</td><td colspan="3">After completing this course, the learner will be able to:
1. Have knowledge about the nature, scope and impact of physics on technological development of the society.
2. Understand and describe motion of an object in one dimension.
3. Understand and describe the laws of motion and their applications in daily life.
4. Understand and appreciate the importance of laws of conservation of energy and momentum in daily life.
5. Learn to present observations, results, analysis and different concepts related to experiments of Physics Fundamental –I</td></tr>
<tr><td rowspan="2">Credits</td><td>Theory</td><td>Practical</td><td>Total</td></tr>
<tr><td>2</td><td>1</td><td>3</td></tr>
<tr><td>Contact Hours</td><td>2</td><td>2</td><td>4</td></tr>
<tr><td colspan="2">Max. Marks:75
Internal Assessment Marks:20
End Term Exam Marks: 55</td><td colspan="2">Time:3hrs</td></tr>
<tr><td colspan="4">Part B- Contents of the Course</td></tr>
<tr><td colspan="4"><u>Instructions for Paper- Setter</u>
1.Nine questions will be set in total.</td></tr>
</table>

2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.

3. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.

4. 20% numerical problems are to be set.

5. Use of scientific (non-programmable) calculator is allowed.

Unit	Topics	Contact Hours
I	Physics-Nature, scope & excitement, Major discoveries in physics, major contribution by Indian Physicists, Physics in relation to other sciences, Impact of Physics on Society, latest developments in Science and Technology. System of Measuring Units-Need for measurement, measuring process, concept of mass, length, time; Fundamental and derive units, system of units, concepts of error, types of error (only definition), Accuracy and precision in measurement, least count and applications of measuring instruments - Vernier caliper, Screw Gauge	8
II	Motion of objects in one dimension- position of the object, origin/reference point, frame of reference, definitions and examples of motion in one, two and three dimension, Scalar and Vector quantities, description of motion along a straight line- distance and displacement, uniform motion and non-uniform motion, average and instantaneous speed, average and instantaneous velocity, acceleration; graphical analysis of straight line motion- distance- time graph, velocity-time graph.	8
III	Causes of motion- concept of force, Newton's Ist law of motion, inertia and mass; Newton's 2^{nd} law of motion, momentum and force; 3^{rd} law of motion, daily life applications of Newton's laws of motion. Universal law of gravitation and its importance, acceleration due to gravity and free fall of a body; mass and weight of an object on earth and moon, concept of thrust and pressure and importance in daily life.	7
IV	Work, energy, types of energy-Kinetic energy and Potential energy, P.E. of an object at a height; law of conservation of energy and its applications. Conservation of linear and angular momentum, collision (elastic and inelastic) and conservation laws in collisions- importance in daily life.	7
	Practicum 1. To measure the diameter of a small spherical / cylindrical body. 2. To measure the length, width and height of the given rectangular block. 3. To measure the internal diameter and depth of a given beaker/calorimeter and hence find its volume. 4. Use of screw gauge:(i) to measure diameter of a given wire and (ii) to measure thickness of a given sheet 5. To determine radius of curvature of a given spherical surface by a spherometer. 6. To find the downward force, along an inclined plane, acting on a roller due to gravitational pull of the earth and study its relationship with the angle of inclination by plotting graph between force and sin θ	30

	7. To find the weight of a given body using parallelogram law of vectors. 8. Verification of Archimedes principle. 9. Verification of Work-energy theorem. 10. Acceleration due to gravity (g) by bar pendulum. 11. To determine the moment of Inertia of a fly-wheel. 12. Study of law of conservation of linear momentum and KE. **Note: Student will perform at least five experiments. The examiner will allot one practical at the time of end term examination.**	

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory (15 Marks)** • Class Participation: **04 Marks** • Seminar/presentation/assignment/quiz/class test etc.: **04 Marks** • Mid-Term Exam: **7 Marks** ➢ **Practicum (5 Marks)** • Class Participation: **Nil** • Seminar/Demonstration/Viva-voce/Lab records etc.: **5 Marks** • Mid-Term Exam: **Nil**	**End Term Examination : 35 Marks** **: 20 Marks**

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Essential University Physics, Vol.-1 &2 by Richard Wolfson, Pearson Education, Patparganj, Delhi, India.
2. Concept of Physics by H.C. Verma, Bharti Bhawan, Ansari Road, Daryaganj, New Delhi, India.
3. Modern Physics (2^{nd} edition), by S.L. Kakani and Shubhra Kakani, Viva Books, New Delhi.
4. Physics for Scientists and Engineers with Modern Physics, 7^{th} edition, by Raymond A. Serway and John W. Jewett, Jr., Thomson Higher Education 10 Davis Drive Belmont, CA 94002-3098 USA.
5. Physics For You, Fifth Edition, by Keith Johnson, OUP Oxford; 5th edition (23 June 2016).
6. B.Sc Practical Physics, C. L. Arora, R Chand & Co. New Delhi
7. B.Sc Practical Physics, Harnam Singh and Dr. P.S. Hemne, S Chand & Company Ltd.

Ch. Ranbir Singh University, Jind
Undergraduate Programs
Course: CC-2/MCC-3

Session: 2023-24			
Part A - Introduction			
Subject	Physics		
Semester	2nd		
Name of the Course	**Electricity, Magnetism and EM Theory**		
Course Code	B23-PHY-201		
Course Type: (CC/MCC/MDC/CC-M/ DSEC /VOC/DSE/PC/AEC/VAC)	CC/MCC		
Level of the course (As per Annexure-I	100-199		
Pre-requisite for the course (if any)	Appeared or passed the 1st sem (B.Sc. Physical Science/ equivalent)		
Course Learning Outcomes(CLO):	After completing this course, the learner will be able to: 1. Explain and differentiate the vector and scalar formalisms of electrostatics. Also be able to apply Gauss's Divergence & Stokes theorem to solve various problems in electrostatics 2. Describe the magnetic materials & important properties of magnetic field. Understand the properties and theories of dia-, para- & ferromagnetic materials. 3. Derive Maxwell equations and their physical significance and familiar about the propagation of electromagnetic waves i.e. boundary conditions at the interface between different media. The students will also be able to have basic idea about the propagation of electromagnetic waves in free space and in medium. 4. Understand D.C. and A.C. circuits, able to apply and analyse using networks. Analyze DC/AC circuits consisting of parallel and/or series combinations of voltage sources and resistors and to describe the graphical relationship of resistance, capacitor and inductor. 5. Learn to present observations, results, analysis and different concepts related to experiments of Electricity and Magnetism.		
Credits	Theory	Practical	Total

	3	1	4
Contact Hours	3	2	5

Max. Marks:100 **Internal Assessment Marks:30** **End Term Exam Marks: 70**	**Time:3hrs**

Part B- Contents of the Course

Instructions for Paper- Setter

1.Nine questions will be set in total.

2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.

3. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.

4. 20% numerical problems are to be set.

5. Use of scientific (non-programmable) calculator is allowed.

Unit	Topics	Contact Hours
I	**Vector Background** a**nd Electric Field** : Gradient of a scalar and its physical significance, Line, Surface and Volume integrals of a vector and their physical significance, Flux of a vector field, Divergence and curl of a vector and their physical significance, Gauss's divergence theorem, Stoke's theorem. Conservative nature of Electrostatic Field, Electrostatic Potential, Potential as line integral of field, potential difference Derivation of electric field E from potential as gradient. Derivation of Laplace and Poisson equations. Electric flux, Gauss's Law, Differential form of Gauss's law and applications of Gauss's law. Mechanical force of charged surface, Energy per unit volume.	11
II	**Magnetic Field:** Biot-Savart law and its simple applications: straight wire and circular loop, Current Loop as a Magnetic Dipole and its Dipole Moment, Ampere's Circuital Law and its applications to (1) Solenoid and (2) Toroid, properties of B: curl and divergence, **Magnetic Properties of Matter:** Force on a dipole in an external field, Electric currents in Atoms, Electron spin and Magnetic moment, types of magnetic materials, Magnetization vector (M), Magnetic Intensity (H), Magnetic Susceptibility and permeability, Relation between B, H and M, Electronic theory of dia and paramagnetism, Domain theory of ferromagnetism (Langevin's theory), Cycle of Magnetization- B-H curve and hysteresis loop: Energy dissipation, Hysteresis loss and importance of Hysteresis Curve	12
III	**Time varying electromagnetic fields:** Electromagnetic induction, Faraday's laws of induction and Lenz's Law, Self-inductance, Mutual inductance, Energy stored in a Magnetic field, Derivation of Maxwell's equations, Displacement current, Maxwell's equations in differential and integral form and their physical significance.	11

	Electromagnetic Waves: Electromagnetic waves, Transverse nature of electromagnetic wave, energy transported by electromagnetic waves, Poynting vector, Poynting's theorem.	
IV	**DC current Circuits:** Electric currents and current density, Electrical conductivity and Ohm's law (Review), Kirchhoff's laws for D.C. networks. **Alternating Current Circuits:** A resonance circuit, Phasor, Complex Reactance and Impedance, Analysis for RL, RC and RLC Circuits, Series LCR Circuit: (1) Resonance, (2) Power Dissipation (3) Quality Factor and (4) Band Width, Parallel LCR Circuit.	10
	Practicum 1. Use of Multimeter for measuring Resistance, A.C. and D.C. Voltage and Current, checking of electrical fuses. 2. Low resistance by Carey Foster's bridge with calibration. 3. Determination of Impedance of an A.C. circuit and its verification. 4. Frequency of A.C. mains using an electromagnet. 5. Frequency of A.C. mains Electrical vibrator. 6. High resistance by substitution method. 7. To compare capacitances using De'Sauty's bridge. 8. To study the Characteristics of a Series RC Circuit. 9. To study a series LCR circuit LCR circuit and determine its (a) Resonant frequency, (b) Quality factor. 10. To study a parallel LCR circuit and determine its (a) Anti-resonant frequency and (b) Quality factor Q. 11. Self-inductance by Anderson's bridge. 12. Verification of laws of electromagnetic induction. 13. Study of B-H curves of various materials using C.R.O, and determination of various parameters. **Note: Student will perform at least five experiments. The examiner will allot one practical at the time of end term examination.**	30
Suggested Evaluation Methods		
Internal Assessment: ➢ **Theory (20 Marks)** • Class Participation: **05 Marks** • Seminar/presentation/assignment/quiz/class test etc.: **05 Marks** • Mid-Term Exam: **10 Marks** ➢ **Practicum (10 Marks)** • Class Participation: **Nil** • Seminar/Demonstration/Viva-voce/Lab records etc.: **10 Marks** • Mid-Term Exam: **Nil**		**End Term Examination : 50 Marks** **20 Marks**
Part C-Learning Resources		

Recommended Books/e-resources/LMS:

1. Electricity and Magnetism (Berkley, Phys. Course 2), Edward M. Purcell, 1986 McGraw-Hill Education
2. Electricity and Magnetism: A.S. Mahajan & A.A. Rangwala (Tata- McGraw Hill), 1988.
3. Electricity, Magnetism & Electromagnetic Theory, S. Mahajan and Choudhury, 2012, Tata McGraw
4. Introduction to Electrodynamics, D.J. Griffiths, 3rd Edn., 1998, Benjamin Cummings.
5. Feynman Lectures Vol.2, R.P. Feynman, R.B. Leighton, M. Sands, 2008, Pearson Education
6. Elements of Electromagnetics, M.N.O. Sadiku, 2010, Oxford University Press.
7. Electricity and Magnetism, J.H.Fewkes & J.Yarwood. Vol. I, 1991, Oxford Univ. Press.
8. Field and Wave Electromagnetics (2^{nd} Edn.), David K. Cheng , Addison-Wesley Publishing Company.
9. B.Sc. Practical Physics, C.L. Arora, S. Chand Publisher, New Delhi
10. Advanced Level Practical Physics, M. Nelkon and Ogborn, Henemann Education Books Ltd., New Delhi
11. Practical Physics, S.S. Srivastava and M.K. Gupta, Atma Ram & Sons, Delhi
12. Practical Physics, S.L. Gupta and V. Kumar, Pragati Prakashan Meerut
13. Modern Approach to Practical Physics, R.K. Singla, Modern Publishers, Jalandhar
14. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, Asia Publishing House

Ch. Ranbir Singh University, Jind
Undergraduate Programs
Course: CC-M2

Session: 2023-24			
Part A - Introduction			
Subject	Physics		
Semester	2nd		
Name of the Course	**Elementary Electricity, Magnetism & Electromagnetic Theory**		
Course Code	B23-PHY-202		
Course Type: (CC/MCC/MDC/CC-M/ DSEC /VOC/DSE/PC/AEC/VAC)	CC-M		
Level of the course (As per Annexure-I	100-199		
Pre-requisite for the course (if any)	Physics not as major subject in 2nd sem		
Course Learning Outcomes(CLO):	After completing this course, the learner will be able to: 1. Explain and differentiate the vector and scalar formalisms of electrostatics. Also be able to apply Gauss's Divergence & Stokes theorem to solve various problems in electrostatics 2. Describe the magnetic materials & important properties of magnetic field. Understand the properties and theories of dia-, para- & ferromagnetic materials 3. Derive Maxwell equations and their physical significance and familiar boundary conditions at the interface between different media. The students will also be able to have basic idea about the propagation of electromagnetic waves 4. Analyze DC/AC circuits consisting of parallel and/or series combinations of voltage sources and resistors and to describe the graphical relationship of resistance, capacitor and inductor 5. Learn to present observations, results, analysis and different concepts related to experiments of Electricity and Magnetism		
Credits	Theory	Practical	Total
	1	1	2

Contact Hours	1	2	3

Max. Marks:50 **Internal Assessment Marks:15** **End Term Exam Marks: 35**	**Time:3hrs**

Part B- Contents of the Course

Instructions for Paper- Setter

1.Nine questions will be set in total.

2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.

3. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.

4. 20% numerical problems are to be set.

5. Use of scientific (non-programmable) calculator is allowed.

Unit	Topics	Contact Hours
I	**Vector background and electric field:** Gradient of a scalar and its physical significance, Line, Surface and Volume integrals of a vector and their physical significance, Flux of a vector field, Divergence and curl of a vector and their physical significance, Gauss's divergence theorem, Stoke's theorem.	4
II	**Magnetic field and magnetic properties :** Magnetic induction, Magnetic flux, Solenoidal nature of vector field of induction, properties of $\vec{B}$ (i) $\nabla.\vec{B} = 0$ (ii) $\nabla \times \vec{B} = \mu_o \vec{J}$, Magnetic Materials, types, Hysteresis curve and importance of Hysteresis Curve.	3
III	**Time varying electromagnetic fields and electromagnetic waves :** Electromagnetic induction, Faraday's laws of induction and Lenz's Law, Derivation of Maxwell's equations and their physical significance. Boundary conditions at interface between two different media, Propagation of electromagnetic wave (Basic idea, no derivation), Poynting vector and Poynting theorem.	4
IV	**DC current Circuits:** Electric currents and current density, Electrical conductivity and Ohm's law (Review), Kirchhoff's laws for D.C. networks.	4
	Practicum 1. Use of Multimeter for measuring Resistance, A.C. and D.C. Voltage and Current, checking of electrical fuses. 2. Low resistance by Carey Foster's bridge with calibration. 3. Determination of Impedance of an A.C. circuit and its verification. 4. Frequency of A.C. mains using an electromagnet. 5. Frequency of A.C. mains Electrical vibrator. 6. High resistance by substitution method. 7. To compare capacitances using De'Sauty's bridge. 8. To study the Characteristics of a Series RC Circuit.	30

	9. To study a series LCR circuit LCR circuit and determine its (a) Resonant frequency, (b) Quality factor. 10. To study a parallel LCR circuit and determine its (a) Anti-resonant frequency and (b) Quality factor Q. **Note: Student will perform at least five experiments. The examiner will allot one practical at the time of end term examination.**	

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory (10 Marks)** • Class Participation: **04 Marks** • Seminar/presentation/assignment/quiz/class test etc.: **Nil** • Mid-Term Exam: **6 Marks** ➢ **Practicum (5 Marks)** • Class Participation: **Nil** • Seminar/Demonstration/Viva-voce/Lab records etc.: 0**5 Marks** • Mid-Term Exam: **Nil**	**End Term Examination : 20 Marks** **: 15 Marks**

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Electricity and Magnetism (Berkley, Phys. Course 2), Edward M. Purcell, 1986 McGraw-Hill Education
2. Electricity and Magnetism: A.S. Mahajan & A.A. Rangwala (Tata- McGraw Hill), 1988.
3. Electricity, Magnetism & Electromagnetic Theory, S. Mahajan and Choudhury, 2012, Tata McGraw
4. Introduction to Electrodynamics, D.J. Griffiths, 3rd Edn., 1998, Benjamin Cummings.
5. Feynman Lectures Vol.2, R.P. Feynman, R.B. Leighton, M. Sands, 2008, Pearson Education
6. Elements of Electromagnetics, M.N.O. Sadiku, 2010, Oxford University Press.
7. Electricity and Magnetism, J.H.Fewkes & J.Yarwood. Vol. I, 1991, Oxford Univ. Press.
8. Field and Wave Electromagnetics (2^{nd} Edn.), David K. Cheng , Addison-Wesley Publishing Company.

Ch. Ranbir Singh University, Jind
Undergraduate Programs
Course: DSEC-1

<table>
<tr><td colspan="4">Session: 2023-24</td></tr>
<tr><td colspan="4">Part A - Introduction</td></tr>
<tr><td>Subject</td><td colspan="3">Physics</td></tr>
<tr><td>Semester</td><td colspan="3">2nd</td></tr>
<tr><td>Name of the Course</td><td colspan="3">Computational Physics</td></tr>
<tr><td>Course Code</td><td colspan="3">B23-PHY-203</td></tr>
<tr><td>Course Type: (CC/MCC/MDC/CC-M/ DSEC /VOC/DSE/PC/AEC/VAC)</td><td colspan="3">DSEC</td></tr>
<tr><td>Level of the course (As per Annexure-I</td><td colspan="3">100-199</td></tr>
<tr><td>Pre-requisite for the course (if any)</td><td colspan="3">Appeared or passed the 1st sem (B.Sc. Physical Science/ equivalent)</td></tr>
<tr><td>Course Learning Outcomes(CLO):</td><td colspan="3">After completing this course, the learner will be able to:
1. Understand the programming language and their use in various applications
2. Develop Python programs to solve computational problems
3. Select a suitable programming to solve differential equations
4. Find the integral value of a function using appropriate method.
5. Understand how to develop a programme for a particular problem and it will improve logical thinking that helps to solve scientific problems using Python language.</td></tr>
<tr><td rowspan="2">Credits</td><td>Theory</td><td>Practical</td><td>Total</td></tr>
<tr><td>3</td><td>1</td><td>4</td></tr>
<tr><td>Contact Hours</td><td>3</td><td>2</td><td>5</td></tr>
<tr><td colspan="2">Max. Marks:100
Internal Assessment Marks:30
End Term Exam Marks: 70</td><td colspan="2">Time:3hrs</td></tr>
<tr><td colspan="4">Part B- Contents of the Course</td></tr>
<tr><td colspan="4">Instructions for Paper- Setter</td></tr>
</table>

1.Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.
3. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.
4. 20% numerical problems are to be set.
5. Use of scientific (non-programmable) calculator is allowed.

Unit	Topics	Contact Hours
I	**Introduction to Programming using Python**: Structure of a Python Program, Functions, Interpreter shell, Indentation. Identifiers and keywords, Literals, Strings, Basic operators (Arithmetic operator, Relational operator, Logical or Boolean operator, Assignment Operator, Bit wise operator). Standard libraries in Python, notion of class, object and method.	11
II	**Creating Python Programs**: Identifiers and keywords; Literals, numbers, and strings; Operators; Expressions; Input/output statements; Defining functions; Control structures (conditional statements, loop control statements, break, continue and pass, exit function), default arguments. Mutable and immutable objects. Testing and debugging a program	12
III	**Differentiation:** Taylor series method, Newton's forward and backward difference formula, Stirling's formula. Numerical solutions of partial differential equations using Taylors's series method	11
IV	**Integration:** Trapezoidal rule, Simpson's 1/3 and 3/8 rule, Gaussian Quadrature, Legendre– Gauss Quadrature, Numerical double integration.	11
	Practicum 1. Write a Python program to illustrate the various functions of the "Math" module. 2. Write a function that takes the lengths of three sides: side1, side2 and side3 of the triangle as the input from the user using input function and return the area of the triangle as the output. Also, assert that sum of the length of any two sides is greater than the third side. 3. Write a Python function that takes a number as an input from the user and computes its factorial. 4. Write a function that takes a number with two or more digits as an input and finds its reverse and computes the sum of its digits. 5. Write a function that takes two numbers as input parameters and returns their least common multiple and highest common factor. 6. Write a Python function to calculate the sum and product of two compatible matrices. 7. Write a function that takes a list of numbers as input from the user and produces the corresponding cumulative list where each element in the list present at index i is the sum of elements at index j <= i. 8. Write a function that takes n as an input and creates a list of n lists such that ith list contains first five multiples of i. 9. Solution of differential equations using Taylor's series method**.**	30

	10. Numerical integration using (a) Simpson 1/3 and 3/8 rule 11. Gauss quadrature methods for one and two dimensional integrals **Note: Student will perform at least five experiments. The examiner will allot one practical at the time of end term examination.**	

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory (20 Marks)** • Class Participation: **05 Marks** • Seminar/presentation/assignment/quiz/class test etc.: **05 Marks** • Mid-Term Exam: **10 Marks** ➢ **Practicum (10 Marks)** • Class Participation: **Nil** • Seminar/Demonstration/Viva-voce/Lab records etc.: **10 Marks** • Mid-Term Exam: **Nil**	**End Term Examination : 50 Marks** **: 20 Marks**

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Sheetal Taneja, Naveen Kumar, Python Programming "A Modular Approach" Pearson India.
2. E. Balaguruswamy, Introduction to Computing and Problem Solving using Python, 2nd edition, McGraw Hill Education, 2018
3. R C Desai, Fortran Programming and Numerical methods, Tata McGraw Hill, New Delhi.
4. Suresh Chandra, Computer Applications in Physics, Narosa Publishing House
5. M L De Jong, Introduction to Computation Physics, Addison-Wesley publishing company.
6. R C Verma, P K Ahluwalia and K C Sharma, Computational Physics an Introduction, New Age International Publisher.
7. S S Sastry Introductory methods of numerical Analysis, Prentice Hall of India Pvt. Ltd.
8. V Rajaraman, Computer Oriented Numerical Method, Prentice Hall of India Pvt. Ltd.
9. C Balachandra Rao and C K Santha, Numerical Methods, University Press
10. K E Atkinson, An introduction to numerical analysis, John Wiley and Sons.

Ch. Ranbir Singh University, Jind
Undergraduate Programs
Course: MDC-2

Session: 2023-24			
Part A - Introduction			
Subject	Physics		
Semester	2nd		
Name of the Course	**Physics Fundamentals-II**		
Course Code	B23-PHY-204		
Course Type: (CC/MCC/MDC/CC-M/ DSEC /VOC/DSE/PC/AEC/VAC)	MDC		
Level of the course (As per Annexure-I	100-199		
Pre-requisite for the course (if any)	Not studied Physics subject at level 4 (i.e. 10+2 or equivalent)		
Course Learning Outcomes(CLO):	After completing this course, the learner will be able to: 1. Have basic knowledge about nature of light, the associated phenomena and their importance in daily life 2. Understand and describe the working of important optical instruments through the learning of image formation by mirrors and lenses 3. Have basic knowledge about electric current, electric circuit, electric components, and practical utility of heating and magnetic effects of electric current 4. Grasp an introductory idea about the generation of X-rays, α-, β- and γ-rays through an understanding of composition of atom & nucleus 5. Understand the observations, results, analysis and different concepts related to experiments of light & optics.		
Credits	Theory	Practical	Total
	2	1	3
Contact Hours	2	2	4

Max. Marks:75 **Internal Assessment Marks:20** **End Term Exam Marks: 55**	**Time:3hrs**

Part B- Contents of the Course

Instructions for Paper- Setter

1.Nine questions will be set in total.

2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.

3. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.

4. 20% numerical problems are to be set.

5. Use of scientific (non-programmable) calculator is allowed.

Unit	Topics	Contact Hours
I	**Light and optics**-Nature and properties of light, its speed, frequency and wavelength; Reflection of light-types of reflection and their importance in daily life, laws of reflection. **Refraction of light**- laws of refraction, refractive index, refraction of light through prism (dispersion of light), formation Rainbow, twinkling of stars, advance Sunrise and delayed Sunset; Scattering of light and blue colour of the sky; apparent depth, total internal reflection.	7
II	**Image formation through reflection**-images formed by plane mirrors, multiple images formed by two flat mirrors and optical illusions; images formed by parabolic mirrors and spherical mirrors- Concave and convex mirrors, ray diagrams, mirror equation and magnification; applications of plane and curved mirrors in daily life. **Image formation through refraction**- images by convex and concave lenses, ray diagrams and lens equation.	8
III	**Electricity-** electric charge, types of charges, unit of charge, frictional electricity, electricity by conduction and electric current, units of electric current, measurement of current, conductors and insulators; resistance, resistivity and Ohm's law, electric potential and potential difference, emf; **Electric circuit**- resistor, capacitor, battery, ammeter and voltmeter; Series and parallel combinations of resistors, electrical wiring in houses and electrical safety (fuse, hot wire, neutral, ground and short circuit), electric power and electric power transmission current and its practical applications. **Magnetic effect of electric current-** Magnetic field and field lines, bar magnet, magnetic field and direction of field due to a current- through straight conductor.	8
IV	**Structure of an atom**- Rutherford's model of an atom, Bohr's model of an atom and composition of the atom-electron, proton and neutron, orbits or shells (energy levels in an atom), distribution of electrons in different shells	7

	of the atom, atomic number and atomic mass of an atom, valency of an atom, excitation and ionization of the atom, meaning of atomic transitions; Discovery of X-rays, Generation of X-rays, Composition of nucleus, meaning of nuclear transitions.	
	Practicum 1. To find the focal length of a convex mirror using a convex lens. 2. To find the value of v for different values of u in the case of a concave mirror and to find the focal length 3. To find the focal length of a concave lens using a convex lens. 4. To determine the refractive index of a glass slab 5. To find the refractive index of a liquid using a convex lens and plane mirror 6. To determine the resistivity of different wires by plotting a graph for potential difference versus current. 7. To verify Ohm's law for metallic conductor and to determine its resistance. 8. To find the frequency of AC mains with a sonometer. 9. Use of Multimeter for measuring Resistance, A.C. and D.C. Voltage and Current, checking of electrical fuses. 10. Use of Multimeter to check the working condition of diode, an LED, a resistor and a capacitor. **Note: Student will perform at least five experiments. The examiner will allot one practical at the time of end term examination.**	30

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory (15 Marks)** • Class Participation: **04 Marks** • Seminar/presentation/assignment/quiz/class test etc.: **04 Marks** • Mid-Term Exam: **7 Marks** ➢ **Practicum (05 Marks)** • Class Participation: **Nil** • Seminar/Demonstration/Viva-voce/Lab records etc.: **05 Marks** • Mid-Term Exam: **Nil**	**End Term Examination : 35 Marks** **20 Marks**

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Essential University Physics, Vol.-1 &2 by Richard Wolfson, Pearson Education, Patparganj, Delhi, India.
2. Concept of Physics by H.C. Verma, Bharti Bhawan, Ansari Road, Daryaganj, New Delhi, India.
3. Modern Physics (2^{nd} edition), by S.L. Kakani and Shubhra Kakani, Viva Books, New Delhi.
4. Physics for Scientists and Engineers with Modern Physics, 7^{th} edition, by Raymond A. Serway and John W. Jewett, Jr., Thomson Higher Education 10 Davis Drive Belmont, CA 94002-3098 USA.
5. Physics For You, Fifth Edition, by Keith Johnson, OUP Oxford; 5th edition (23 June 2016).
6. B.Sc Practical Physics, C. L. Arora, R Chand & Co. New Delhi

7. B.Sc Practical Physics, Harnam Singh and Dr. P.S. Hemne, S Chand & Company Ltd.

Ch. Ranbir Singh University, Jind
Undergraduate Programs
Course: CC-3/MCC-4

Session: 2023-24			
Part A - Introduction			
Subject	Physics		
Semester	3rd		
Name of the Course	**Thermodynamics & Statistical Physics**		
Course Code	B23-PHY-301		
Course Type: (CC/MCC/MDC/CC-M/ DSEC /VOC/DSE/PC/AEC/VAC)	CC/MCC		
Level of the course (As per Annexure-I	100-199		
Pre-requisite for the course (if any)	Appeared or passed the 2nd sem (B.Sc. Physical Science/ equivalent)		
Course Learning Outcomes(CLO):	After completing this course, the learner will be able to: 1. Understand and describe the basic concepts and laws of thermodynamics 2. Apply the laws of thermodynamics to develop Maxwell's thermodynamic relations be able to understand their physical interpretations 3. Appreciate cellular nature of phase space and Have better knowledge of classical statistics which would result in greater insight into solutions of various complex problems 4. Have better understanding of quantum statistics and are in a position to extend the treatment to the analysis of complex problems 5. Learn to present observations, results, analysis and different concepts of experiments related to Thermodynamics & Statistical Physics		
Credits	Theory	Practical	Total
	3	1	4
Contact Hours	3	2	5

Max. Marks:100 **Internal Assessment Marks:30** **End Term Exam Marks: 70**	**Time:3hrs**

Part B- Contents of the Course

Instructions for Paper- Setter

1. Nine questions will be set in total.

2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.

3. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.

4. 20% numerical problems are to be set.

5. Use of scientific (non-programmable) calculator is allowed.

Unit	Topics	Contact Hours
I	**THERMODYNAMICS-I** Laws of Thermodynamics: Thermodynamic Description of system: Zeroth Law of thermodynamics. First law of thermodynamics and internal energy, conversion of heat into work, Various Thermodynamical Processes, Applications of First Law: Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion Coefficient, Reversible and irreversible processes, Second law of thermodynamics, Entropy, Carnot's cycle & Carnot's theorem, Entropy changes in reversible and irreversible processes, Entropy-temperature diagrams, Third law of thermodynamics, Unattainability of absolute zero.	11
II	**THERMODYNAMICS-II** Thermodynamic Potentials: Enthalpy, Gibbs, Helmholtz and Internal Energy functions, Maxwell's relations and applications - Joule-Thompson Effect, Clausius- Clapeyron Equation, Expression for (C_P – C_V), C_P/C_V, TdS equations.	11
III	**Statistical Physics-I**	12

	Basics idea of probability, Priori probability, Statistical probability, permutation and combination, distinguishable and indistinguishable particles Distribution of N (for N= 2, 3, 4) distinguishable and indistinguishable particles in two boxes of equal size, microstates and macrostates, thermodynamical probability, constraints and accessible states, statistical fluctuations, entropy and probability; Concept of phase space, division of phase space into cells, postulates of statistical mechanics; Classical and quantum statistics, basic approach to these statistics, Maxwell-Boltzmann statistics applied to an ideal gas in equilibrium-energy distribution law, Maxwell's distribution of speed & velocity (derivation required), most probable speed, average and r.m.s. speed, mean energy for Maxwellian distribution.	
IV	**Statistical Physics-II** Need of Quantum statistics- classical versus quantum statistics, Bose-Einstein energy distribution Law, Application of B. E. Statistics to Planck's radiation law, Fermi-Dirac energy distribution Law, Fermi energy and Fermi temperature; F. D. energy distribution Law for electron gas in metals, zero point energy, average speed (at 0 K) of electron gas	11
	<u>Practicum</u> 1. To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method. 2. To determine Stefan's Constant. 3. To determine the coefficient of thermal conductivity of copper by Searle's Apparatus. 4. To determine the coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method. 5. To determine the temperature co-efficient of resistance by Platinum resistance thermometer. 6. To study the variation of thermo emf across two junctions of a thermocouple with temperature. 7. To record and analyze the cooling temperature of an hot object as a function of time using a thermocouple/thermometer and suitable data acquisition system 8. To calibrate Resistance Temperature Device (RTD) using Null Method/Off-Balance Bridge 9. To prove the law of probability by using one coin, two coins and 10 or more coins. 10. To determine the coefficient of increase of volume of air at constant pressure. 11. To determine the coefficient of increase of pressure of air at constant volume. 12. To study the relationship between the temperature of a hot body and time by plotting a cooling curve. 13. To verify the zeroth law of thermodynamics 14. Study of statistical distribution from the given data and to find most probable, average, and rms value	30

	15. Mechanical Equivalent of heat (J) by Joule's calorimeter. 16. Heating efficiency of electrical kettle with varying voltage. **Use C/C++/Scilab/Fortarn/MATLAB/ any other numerical simulations for solving the problems based on Thermodynamics/ Statistical Mechanics like** 17. Measurement of Planck's constant using black body radiation. 18. Computer simulation of Maxwell-Boltzmann distribution. 19. Computer simulation of Bose- Einstein distribution 20. Computer simulation of Fermi- Dirac distribution. 21. Computation of the velocity distribution of particles for the system and comparison with the Maxwell velocity distribution	

	Note: Student will perform at least five experiments. The examiner will allot one practical at the time of end term examination.	
Suggested Evaluation Methods		
Internal Assessment: ➢ **Theory (20 Marks)** • Class Participation: **05 Marks** • Seminar/presentation/assignment/quiz/class test etc.: **05 Marks** • Mid-Term Exam: **10 Marks** ➢ **Practicum (10 Marks)** • Class Participation: **Nil** • Seminar/Demonstration/Viva-voce/Lab records etc.: **10 Marks** • Mid-Term Exam: **Nil**		**End Term Examination : 50 Marks** **20 Marks**
Part C-Learning Resources		

Recommended Books/e-resources/LMS:

1. Thermal Physics and Statistical Mechanics, S.K. Roy, New Age International Publishers, New Delhi
2. Thermodynamics and Statistical Physics, J.K. Sharma and K.K. Sarkar, Himalaya Publishing House, Bombay
3. Introduction to Thermodynamics and its Applications, Stowe Keith, University Press (India) Pvt. Ltd, Hyderabad
4. Introductory Thermodynamics, Pierre Infelta, BrownWalker Press, Boca Ratan, Florida
5. Fundamentals of Thermodynamics, J. K. Johnson, University of Pittsburgh 2009
6. Thermodynamics and Its Applications, Jefferson Tester, Michael Modell, 3rd Edition
7. Thermodynamics, Statistical Thermodynamics & Kinetics, Thomas Engel, Philip Reid, 2nd Edition
8. Advanced Practical Physics for students, B.L.Flint & H.T.Worsnop, 1971, Asia Publishing House.
9. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
10. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.
11. A Laboratory Manual of Physics for Undergraduate Classes, D.P. Khandelwal, 1985, Vani Publication.

Ch. Ranbir Singh University, Jind
Undergraduate Programs
Course: CCM3

<table>
<tr><th colspan="4">Session: 2023-24</th></tr>
<tr><th colspan="4">Part A - Introduction</th></tr>
<tr><td>Subject</td><td colspan="3">Physics</td></tr>
<tr><td>Semester</td><td colspan="3">3rd</td></tr>
<tr><td>Name of the Course</td><td colspan="3">Thermodynamics</td></tr>
<tr><td>Course Code</td><td colspan="3">B23-PHY-302</td></tr>
<tr><td>Course Type: (CC/MCC/MDC/CC-M/ DSEC /VOC/DSE/PC/AEC/VAC)</td><td colspan="3">CC/MCC</td></tr>
<tr><td>Level of the course (As per Annexure-I</td><td colspan="3">100-199</td></tr>
<tr><td>Pre-requisite for the course (if any)</td><td colspan="3">Appeared or passed the 2nd sem (B.Sc. Physical Science/ equivalent)</td></tr>
<tr><td>Course Learning Outcomes(CLO):</td><td colspan="3">After completing this course, the learner will be able to:
1. Understand and describe the basic concepts and laws of thermodynamics
2. Apply the laws of thermodynamics to develop Maxwell’s thermodynamic relations be able to understand their physical interpretations
3. Understand and describe the concept of kinetic theory of gases.
4. Have better understanding of Maxwell law of speed distribution.
5. Learn to present observations, results, analysis and different concepts of experiments related to Thermodynamics</td></tr>
<tr><td rowspan="2">Credits</td><td>Theory</td><td>Practical</td><td>Total</td></tr>
<tr><td>3</td><td>1</td><td>4</td></tr>
<tr><td>Contact Hours</td><td>3</td><td>2</td><td>5</td></tr>
</table>

Max. Marks:100 **Internal Assessment Marks:30** **End Term Exam Marks: 70**	**Time:3hrs**

Part B- Contents of the Course

Instructions for Paper- Setter

6. Nine questions will be set in total.

7. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.

8. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.

9. 20% numerical problems are to be set.

10. Use of scientific (non-programmable) calculator is allowed.

Unit	Topics	Contact Hours
I	**Laws of Thermodynamics** Thermodynamic Description of system: Zeroth Law of thermodynamics and temperature. First law and internal energy, conversion of heat into work, Various Thermodynamical Processes, Applications of First Law: Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion Coefficient, Reversible and irreversible processes, Second law, Entropy, Carnot's cycle & theorem, Entropy changes in reversible and irreversible processes, Entropy-temperature diagrams, Third law of thermodynamics, Unattainability of absolute zero.	11
II	**Thermodynamic Potentials** Enthalpy, Gibbs, Helmholtz and Internal Energy functions, Maxwell's relations and applications - Joule-Thompson Effect, Clausius- Clapeyron Equation, Expression for (CP – CV), CP/CV, TdS equations.	12
III	**Kinetic theory of gases-I**	
	Assumption of Kinetic theory of gases, pressure of an ideal gas (with derivation), Kinetic interpretation of Temperature, Ideal Gas equation, Degree of freedom, Law of equipartition of energy and its application for specific heat of gases, Real gases, Vander wall's equation, Brownian motion(Qualitative).	11
IV	**Kinetic theory of gases-II** Maxwell's distribution of speed and velocities (derivation required), Experimental verification of Maxwell's law of speed distribution: most probable speed, average and r.m.s. speed, Mean free path, Transport of energy and momentum, Diffusion of gases.	11

	Practicum 1. To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method. 2. Measurement of Planck's constant using black body radiation. 3. To determine Stefan's Constant. 4. To determine the coefficient of thermal conductivity of copper by Searle's Apparatus. 5. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method. 6. To determine the coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method. 7. To determine the temperature co-efficient of resistance by Platinum resistance thermometer. 8. To study the variation of thermo emf across two junctions of a thermocouple with temperature. 9. To record and analyze the cooling temperature of an hot object as a function of time using a thermocouple and suitable data acquisition system 10. To calibrate Resistance Temperature Device (RTD) using Null Method/Off-Balance Bridge 11. To prove the law of probability by using one coin, two coins and 10 or more coins. 12. To determine the coefficient of increase of volume of air at constant pressure. 13. To determine the coefficient of increase of pressure of air at constant volume.	30

	Note: Student will perform at least five experiments. The examiner will allot one practical at the time of end term examination.	

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory (20 Marks)** • Class Participation: **05 Marks** • Seminar/presentation/assignment/quiz/class test etc.: **05 Marks** • Mid-Term Exam: **10 Marks** ➢ **Practicum (10 Marks)** • Class Participation: **Nil** • Seminar/Demonstration/Viva-voce/Lab records etc.: **10 Marks** • Mid-Term Exam: **Nil**	**End Term Examination : 50 Marks** **20 Marks**

Part C-Learning Resources

Recommended Books/e-resources/LMS:

6. Thermal Physics and Statistical Mechanics, S.K. Roy, New Age International Publishers, New Delhi
7. Thermodynamics and Statistical Physics, J.K. Sharma and K.K. Sarkar, Himalaya Publishing House, Bombay
8. Introduction to Thermodynamics and its Applications, Stowe Keith, University Press (India) Pvt. Ltd, Hyderabad
9. Introductory Thermodynamics, Pierre Infelta, BrownWalker Press, Boca Ratan, Florida
10. Fundamentals of Thermodynamics, J. K. Johnson, University of Pittsburgh 2009
11. Thermodynamics and Its Applications, Jefferson Tester, Michael Modell, 3rd Edition
12. Thermodynamics, Statistical Thermodynamics & Kinetics, Thomas Engel, Philip Reid, 2nd Edition
13. Advanced Practical Physics for students, B.L.Flint & H.T.Worsnop, 1971, Asia Publishing House.
14. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
15. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.
16. A Laboratory Manual of Physics for Undergraduate Classes, D.P. Khandelwal, 1985, Vani Publication.

Ch. Ranbir Singh University, JindUndergraduate Programs
Course: MCC-2

Session: 2023-24			
Part A - Introduction			
Subject	Physics		
Semester	3rd		
Name of the Course	**Mathematical Physics**		
Course Code	B23-PHY-102		
Course Type: (CC/MCC/MDC/CC-M/ DSEC /VOC/DSE/PC/AEC/VAC)	MCC		
Level of the course (As per Annexure-I	100-199		
Pre-requisite for the course (if any)	Appeared or passed the 2nd sem (B.Sc. Physical Science/ equivalent)		
Course Learning Outcomes(CLO):	After completing this course, the learner will be able to: 1. Learn the Fourier analysis of periodic functions and their applications in physical problems. Learn the beta, gamma and the error functions and their applications in doing integrations. 2. Acquire knowledge of methods to solve partial differential equations with the examples of important partial differential equations in Physics. 3. Write given function in terms of sine and cosine terms in Fourier series and also to get knowledge in Fourier transforms 4. Learn about beta gamma function, their properties, solve Legendre equations find generating function for Legendre Polynomial, Hermite equation, study orthogonal properties of Hermite Polynomials, recurrence relations.s of complex numbers and their properties such as analyticity, poles and residues. 5. Learn about the methods to solve the mathematical problem using Fortran		
Credits	Theory	Practical	Total
	3	1	4

Contact Hours	3	2	5
Max. Marks:100 **Internal Assessment Marks:30** **End Term Exam Marks: 70**		**Time:3hrs**	

Part B- Contents of the Course

Instructions for Paper- Setter

1. Nine questions will be set in total.

2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.

3. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.

4. 20% numerical problems are to be set.

5. Use of scientific (non-programmable) calculator is allowed.

Unit	Topics	Contact Hours
I	**Theory of Errors:** Systematic and Random errors, Propagation of errors, Normal law of errors, Standard and Probable error, Least square fit, error on slope and intercept of fitted line. **Matrices:** Normal Matrices, Orthogonal Matrices, Hermitian Matrices, Unitary Matrices, Symmetric and Anti-symmetric Matrices, Conjugate of a Matrix, Anti-hermition Matrices, Trace of Matrix, Eigen values and eigen vectors of Matrices, Diagonalization of Matrices.	11
II	**Method of expansion of a function:** Taylor's expansion, Power series, Laurent's theorem. Partial and ordinary differential equations, Partial Differential equations, First order differential equations, Method of separation of variables, Singular points, Vibrations of an elastic string, One dimensional Heat Flow, Heat conduction equation for a 3-dimensional rectangular configuration and apply it to the cooling of a brick (assuming constant initial temperature distribution), vibrations of rectangular and circular membrane, Method of Frobenius, Diffusion equation, Laplace's equation in problems of rectangular , cylindrical and spherical symmetry, Inhomogeneous partial differential equation-Green's function.	12
III	**Fourier series and Integrals:** Introduction, Evaluation of coefficients of Fourier series, cosine series, sine series, Dirichlet's theorem, representation of Even and odd functions, Extension of interval, complex form of Fourier series, Properties of Fourier series: Convergence, Integration, Differentiation, Parseval's theorem, Physical applications of Fourier series analysis: square wave, Half wave rectifier, Full wave rectifier, sawtooth wave, triangular wave, Fourier Integrals, deduction of expressions for the Fourier Transform and its inverse.	11
IV	**Beta and Gamma Functions:** Definition of gamma function, beta function, other forms of beta function,	11

	Relationship between beta and gamma function, Legendre's equation, Legendre's Polynomial, Legendre's function of second kind, General solution of Legendre's equation, Generating function of Legendre's polynomial, orthogonality of Legendre's polynomials, Deduction of Rodrigue's formula for the Legendre's Polynomials, Hermite Polynomial, Hermite differential equation, Generating function of Hermite Polynomial, deduction of recursion relation for H_n of 1^{st} kind and 2^{nd}	
	Practicum **Review of FORTRAN Programming fundamentals:** FORTRAN Preliminaries: Integer and floating point arithmetic expression, built in functions, executable and non-executable statements, input and output statements, Formats, IF, DO and GO TO statements, Dimension arrays, statement function and function subprogram. To print out all natural (even/odd) numbers between given limits using computer. 1. Compute the product of two matrices of different dimension using DO loop 2. Numerical integration by Simpson 1/3 rule 3. Fitting of a straight line using Least-Square method 4. Using array variable, find out the average and standard deviation 5. Write a program to evaluate the function $Y=1 / [C (1 + e \cos \theta)]$ and $V=\sqrt{ [C M G (e2 + e \cos \theta + 1)]}$ e = 1.1, C = 3.0(E+08), M = 5.893(E+24), G = 6.67(E-11) for varying value of θ from 0 to π. 6. To find maximum, minimum and range of a given set of numbers using computer. 7. To evaluate sum of finite series. 8. Find the roots of a quadratic equation. 9. To find integration of a definite integral by trapezoidal rule. 10. To find the area of a triangle, sphere and cylinder. 11. Given values for a, b, c and d and a set of values for the variable x evaluate the function defined by. $f(x) = ax^2 + bx + c$ if $x < d$ $f(x) = 0$ if $x = d$ $f(x) = ax^2 + bx - c$ if $x > d$ For each value of x and print the value of x and f(x). Write a program for an arbitrary number of x values. **Note: Teachers will discuss the fundamentals of FORTRAN Programming to the students. Thereafter student will perform at least five experiments. The examiner will allot one practical at the time of end term examination.**	30
Suggested Evaluation Methods		

Internal Assessment: ➢ **Theory (20 Marks)** • Class Participation: **05 Marks** • Seminar/presentation/assignment/quiz/class test etc.: **05 Marks** • Mid-Term Exam: **10 Marks** ➢ **Practicum (10 Marks)** • Class Participation: **Nil** • Seminar/Demonstration/Viva-voce/Lab records etc.: **10 Marks** • Mid-Term Exam: **Nil**	**End Term Examination : 50 Marks** **20 Marks**

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Mathematical Methods for Physicists: Arfken, Weber, 2005, Harris, Elsevier
2. Fourier Analysis by M.R. Spiegel, 2004, Tata McGraw-Hill.
3. Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole.
4. An Introduction to Ordinary Differential Equations, Earl A Coddington, 1961, PHI Learning.
5. Differential Equations, George F. Simmons, 2006, Tata McGraw-Hill.
6. Essential Mathematical Methods, K.F. Riley and M.P. Hobson, 2011, Cambridge University Press
7. Partial Differential Equations for Scientists and Engineers, S.J. Farlow, 1993, Dover Publications.
8. Mathematical methods for Scientists and Engineers, D.A. McQuarrie, 2003, Viva Books.
9. Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House
10. Advanced level Physics Practical's, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
11. A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Edn, 2011, Kitab Mahal
12. Engineering Practical Physics, S. Panigrahi & B.Mallick, 2015, Cengage Learning India Pvt. Ltd.
13. Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University Press.
14. A Laboratory Manual of Physics for undergraduate classes, D.P. Khandelwal, 1985, Vani Pub.
15. Introduction to Numerical Analysis, S.S. Sastry, 5th Edn. , 2012, PHI Learning Pvt. Ltd.
16. Schaum's Outline of Programming with C++. J. Hubbard, 2000, McGraw-Hill Pub.
17. Numerical Recipes in C: The Art of Scientific Computing, W.H. Pressetal, 3rd Edn. , 2007, Cambridge University Press.
18. A first course in Numerical Methods, U.M. Ascher & C. Greif, 2012, PHI Learning.
19. Elementary Numerical Analysis, K.E. Atkinson, 3rd Edn . , 2007 , Wiley India Edition.
20. Numerical Methods for Scientists & Engineers, R.W. Hamming, 1973, Courier Dover Pub.
21. An Introduction to Computational Physics, T.Pang, 2 nd Edn. , 2006,Cambridge Univ. Press
22. Computational Physics, Darren Walker, 1 st Edn., 2015, Scientific International Pvt. Ltd.

Ch. Ranbir Singh University, Jind
Undergraduate Programs
Course: MCC-5

Session: 2023-24			
Part A - Introduction			
Subject	Physics		
Semester	3rd		
Name of the Course	**Classical Mechanics**		
Course Code	B23-PHY-303		
Course Type: (CC/MCC/MDC/CC-M/ DSEC /VOC/DSE/PC/AEC/VAC)	MCC		
Level of the course (As per Annexure-I	100-199		
Pre-requisite for the course (if any)	Appeared or passed the 2nd sem (B.Sc. Physical Science/ equivalent)		
Course Learning Outcomes(CLO):	After completing this course, the learner will be able to: 1. Learn the concept of conservation of energy, momentum, angular momentum and apply them to understand the basic problems in physics. 2. Understand the importance of Lagrangian & Hamiltonian dynamics and to find the Lagrangian and Hamiltonian for various simple mechanical systems such as Linear Harmonic oscillator, Simple pendulum, Atwood's machine 3. Describe and understand the concepts of central force motion, Kepler's laws of planetary motion and scattering in central force field 4. Learn to present observations, results, analysis and different concepts related to experiments of Classical Mechanics.		
Credits	Theory	Practical	Total
	3	1	4

Contact Hours	3	2	5
Max. Marks:100 **Internal Assessment Marks:30** **End Term Exam Marks: 70**		**Time:3hrs**	

Part B- Contents of the Course

Instructions for Paper- Setter

1. Nine questions will be set in total.

2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.

3. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.

4. 20% numerical problems are to be set.

5. Use of scientific (non-programmable) calculator is allowed.

Unit	Topics	Contact Hours
I	**INTRODUCTORY IDEAS OF CLASSICAL MECHANICS** Newton's Laws of Motion, Space-time reference system; Mechanics of single particle- Conservation Laws of linear momentum, Angular momentum and mechanical energy, Mechanics of a system of particles- Concept of external and internal forces, concept of centre of mass and centre of mass frame of reference, Conservation laws of linear momentum, Angular momentum and mechanical energy, relation between angular momentum and angular momentum about the Centre of Mass.	11
II	**LAGRANGIAN DYNAMICS** Basics concepts about coordinate system, Degrees of freedom; Constraints - Their classification, properties and examples; Generalized coordinates, Transformation equations, Generalized Displacement, Velocity, Acceleration, Momentum, Force and Potential; Principle of Virtual Work & D'Alembert's Principle, Lagrange's equations of motion from D'Alembert's Principle; Concept of symmetry-Homogeneity and isotropy. Problems using Lagrange's equation of motion: spring mass system, Atwood's machine, simple pendulum.	12
III	**HAMILTONIAN DYNAMICS** Generalized Momentum, Cyclic or ignorable coordinates; Integrals of motion, Conservation Theorem, Hamilton's Function and Hamilton's equations of motion, Properties of Hamiltonian and Hamilton's equations of motion; Hamilton's equation in different coordinate system. Formation of Hamiltonian and Hamilton's equation of motion-for-Linear Harmonic oscillator, Atwood's machine, simple pendulum.	11

IV	**MOTION UNDER CENTRAL FORCE** Definition and properties of the central force, two body central force problem-reduction to equivalent one body problem (Lagrangian and Lagrange's equations of motion); differential equation for an orbit, general features of the orbit, stability of the orbits under central force and conditions for closure. Inverse square law- Kepler's law of planetary motion and their derivation.	11
	<u>Practicum</u> 1. To study the Motion of spring and calculate spring constant & value of Acceleration due to Gravity. 2. To determine the value of 'g' by using Kater's pendulum. 3. To study (i) the law of conservation of linear momentum (ii) the law of conservation of kinetic energy and (iii) to calculate the restitution using one dimensional collision apparatus of two hanging spheres. 4. To investigate the motion of coupled oscillators. 5. Surface tension by Quinke's method 6. Young's modulus by Koenig's method. 7. To determine "Y" by optical lever. 8. Viscosity of liquid using Stokes method. 9. To determine the surface tension of a liquid by jaeger's method. 10. To determine the coefficient of Viscosity by Poiseuille's method 11. Verification of parallel & perpendicular axis theorem – using Moment of Inertia. 12. Determination of Log decrement & viscosity. 13. Verification of vibrating string Melde's experiment **Note: Student will perform at least five experiments. The examiner will allot one practical at the time of end term examination.**	30
Suggested Evaluation Methods		

Internal Assessment: ➢ **Theory (20 Marks)** • Class Participation: **05 Marks** • Seminar/presentation/assignment/quiz/class test etc.: **05 Marks** • Mid-Term Exam: **10 Marks** ➢ **Practicum (10 Marks)** • Class Participation: **Nil** • Seminar/Demonstration/Viva-voce/Lab records etc.: **10 Marks** • Mid-Term Exam: **Nil**	**End Term Examination : 50 Marks** **20 Marks**

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Classical Mechanics by H. Goldstein (2nd Edition)
2. Mechanics, D.S. Mathur, S.Chand & Com. Pt. Ltd., New Delhi
3. Classical Mechanics by J. C. Upadhyaya, Himalya Publishing House, Mumbai.
4. Classical Mechanics by S. L. Gupta, V. Kumar & H. V. Sharma, Pragati Prakashan, Meerut.
5. Classical Mechanics by N. C. Rana & P. S. Joag, Tata McGraw-Hill Publishing company Limted, New Delhi
6. B.Sc. Practical Physics, C.L. Arora, S. Chand Publisher, New Delhi
7. Advanced Level Practical Physics, M. Nelkon and Ogborn, Henemann Education Books Ltd., New Delhi
8. Practical Physics, S.S. Srivastava and M.K. Gupta, Atma Ram & Sons, Delhi
9. Practical Physics, S.L. Gupta and V. Kumar, Pragati Prakashan Meerut
10. Modern Approach to Practical Physics, R.K. Singla, Modern Publishers, Jalandhar
11. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, Asia Publishing House.

Ch. Ranbir Singh University, Jind
Undergraduate Programs
Course: MDC-3

<table>
<tr><td colspan="4">Session: 2023-24</td></tr>
<tr><td colspan="4">Part A - Introduction</td></tr>
<tr><td>Subject</td><td colspan="3">Physics</td></tr>
<tr><td>Semester</td><td colspan="3">3rd</td></tr>
<tr><td>Name of the Course</td><td colspan="3">Elements of modern Physics</td></tr>
<tr><td>Course Code</td><td colspan="3">B23-PHY-304</td></tr>
<tr><td>Course Type: (CC/MCC/MDC/CC-M/ DSEC /VOC/DSE/PC/AEC/VAC)</td><td colspan="3">MDC</td></tr>
<tr><td>Level of the course (As per Annexure-I</td><td colspan="3">100-199</td></tr>
<tr><td>Pre-requisite for the course (if any)</td><td colspan="3">Not studied Physics subject at level 4 (i.e. 10+2 or equivalent)</td></tr>
<tr><td>Course Learning Outcomes(CLO):</td><td colspan="3">After completing this course, the learner will be able to:
1. Have introductory idea about the importance of semiconductors and basic semiconductor devices
2. Have the knowledge about the lasers and their importance in scientific and technological fields
3. Understand importance of radioisotopes, Nuclear fission and fusion reactions and their hazardous aspects also
4. Have the knowledge about the importance of some scientifically and technologically advanced materials.
5. Learn to present observations, results, analysis and different concepts related to experiments of Elements of modern Physics.</td></tr>
<tr><td rowspan="2">Credits</td><td>Theory</td><td>Practical</td><td>Total</td></tr>
<tr><td>2</td><td>1</td><td>3</td></tr>
<tr><td>Contact Hours</td><td>2</td><td>2</td><td>4</td></tr>
<tr><td colspan="2">Max. Marks:75
Internal Assessment Marks:20
End Term Exam Marks: 55</td><td colspan="2">Time:3hrs</td></tr>
<tr><td colspan="4">Part B- Contents of the Course</td></tr>
</table>

Instructions for Paper- Setter

1. Nine questions will be set in total.

2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.

3. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.

4. 20% numerical problems are to be set.

5. Use of scientific (non-programmable) calculator is allowed.

Unit	Topics	Contact Hours
I	Basics of semiconductor and semiconductor devices-Atomic structure and energy levels, energy bands (basic idea), definition of conductor, semiconductor and insulators (on the basis of energy gap), Intrinsic semiconductors, extrinsic semiconductors-p-type and n-type semiconductor), P-N junction diode-depletion layer, forward biasing and reverse biasing, V-I characteristics; Working of half wave and full wave rectifiers.	8
II	Basics of Laser systems - introduction to LASER, important properties of laser light, Principle of laser- Light amplification, population inversion and pumping; Working of laser- schematic diagram for functioning of laser, applications of Lasers in different fields of science and technology.	8
III	Introduction to nuclear physics I: Atomic nucleus and the nucleons, atomic number, mass number, isotopes, isobars and isotones; nuclear binding energy, Qualitative idea of liquid drop model. Qualitative idea of radioactivity and different type of radioactive decay- α, β, and γ- decay. Nuclear reactions and their types.	7
IV	Introduction to nuclear physics II: Carbon dating, Nuclear fission reaction and its application as a source of energy (nuclear reactor) and hazardous aspect of nuclear fission; Nuclear fusion reaction and source of stellar energy.	7
	Practicum 1. V-I characteristics of p-n junction diode.	30

	2. V-I characteristics of Zener diode. 3. Characteristics of Solar Cell 4. To verify the inverse square law of light using a photo-voltaic cell. 5. To determine value of Boltzmann constant using V-I characteristic of PN diode. 6. To study the effect of intensity of light (by varying distance of the source) on an LDR 7. To verify the characteristics of LASER 8. To measure the numerical aperture of an optical fibre using He-Ne laser source. 9. Study double slit interference by He-Ne laser 10. Determine the diameter of a wire using (He-Ne Laser) diffraction method **Note: Student will perform at least five experiments. The examiner will allot one practical at the time of end term examination.**	

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory (15 Marks)** • Class Participation: **04 Marks** • Seminar/presentation/assignment/quiz/class test etc.: **04 Marks** • Mid-Term Exam: **7 Marks** ➢ **Practicum (5 Marks)** • Class Participation: **Nil** • Seminar/Demonstration/Viva-voce/Lab records etc.: **5 Marks** • Mid-Term Exam: **Nil**	**End Term Examination : 35 Marks** **: 20 Marks**

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Concept of Modern Physics by Arthur Beiser, McGraw Hill Education.
2. Modern Physics (2^{nd} edition), by S.L. Kakani and Shubhra Kakani, Viva Books, New Delhi.
3. Semiconductor Devices - Physics and Technology by S.M .Sze ,Wiley (1985)
4. Laser and Non-linear optics by B.B.Laud. ,Wiley Eastern Limited (1985)
5. Semiconductor Electronics by A.K.Sharma ,New Age International Publisher(1996)
6. Kenneth S. Krane, Introductory Nuclear Physics, Wiley, New York, 1988
7. Radiation detection and measurement: G.F. Knoll (Wiley, New York) (2000)
8. Verma and Srivastava : Crystallography for Solid State Physics
9. Rajnikant; Solid State Physics, Willey India, 2011.
10. J.C. Anderson, KD. Leaver, R.D. Rawlings and J.M. Alexander, Materials Science, 4th Edition (ChapmanHall, London, 1990).
11. V. Raghavan, Materials Science and Engineering, 3^{rd} Ed. (Prentice-Hall India, New Delhi, 1993).
12. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
13. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn 4 Edition, reprinted

1985, Heinemann Educational Publishers
14. B.Sc Practical Physics, C. L. Arora, R Chand & Co. New Delhi
15. B.Sc Practical Physics, Harnam Singh and Dr. P.S. Hemne, S Chand & Company Ltd.

Ch. Ranbir Singh University, Jind
Undergraduate Programs
Course: CC-4/MCC-6

Session: 2023-24	
Part A - Introduction	
Subject	Physics
Semester	4th
Name of the Course	**Waves and Optics**
Course Code	B23-PHY-401
Course Type: (CC/MCC/MDC/CC-M/ DSEC /VOC/DSE/PC/AEC/VAC)	CC/MCC
Level of the course (As per Annexure-I	100-199
Pre-requisite for the course (if any)	Appeared or passed the 3rd sem (B.Sc. Physical Science/ equivalent)
Course Learning Outcomes(CLO):	After completing this course, the learner will be able to: 1. Have understanding of Interference - by Division of Wave front, by Division of Amplitude and Interference due to transmitted light & reflected light 2. Learn about Huygens-Fresnel's theory, diffraction at a straight edge and at a circular aperture, diffraction due to a narrow slit and due to a narrow wire. Understand and explain the Fraunhoffer diffraction, dispersive power of grating, Rayleigh's criterion and resolving power of telescope & a grating 3. Understand the theories and laws of polarization along with understanding of the production and detection of (i) Plane polarized light (ii) Circularly polarized light and (iii) Elliptically polarized light 4. Understand and appreciate the applications of Lasers in developing LED, Holography, in materials processing, in Medicine, Industry and Military. 5. Understand various optical phenomena, principles, workings and applications optical instruments through Experiments

Credits	Theory	Practical	Total
	3	1	4
Contact Hours	3	2	5
Max. Marks:100 **Internal Assessment Marks:30** **End Term Exam Marks: 70**		**Time:3hrs**	

Part B- Contents of the Course

Instructions for Paper- Setter

1. Nine questions will be set in total.

2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.

3. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.

4. 20% numerical problems are to be set.

5. Use of scientific (non-programmable) calculator is allowed.

Unit	Topics	Contact Hours
I	**INTERFERENCE** **Interference by Division of Wave front:** Young's double slit experiment, Coherence, Conditions of interference, Fresnel's biprism and its applications to determine the wavelength of sodium light and thickness of a mica sheet, phase change on reflection. **Interference by Division of Amplitude:** Plane parallel thin film, production of colors in thin films, classification of fringes in thin films, Interference due to transmitted light and reflected light, wedge shaped film, Newton's rings.	11
II	**DIFFRACTION** Fresnel Diffraction: Half-period zones. Zone plate. Fresnel Diffraction pattern of a straight edge, a slit and a wire using half-period zone analysis. Fraunhoffer diffraction: Single slit diffraction, double slit diffraction, plane transmission grating spectrum, dispersive power of grating, limit of resolution, Rayleigh's criterion, resolving power of telescope and grating.	11
III	**POLARIZATION** Polarization: Polarisation by reflection, refraction and scattering, Malus Law, Phenomenon of double refraction, Huygens's wave theory of double refraction (Normal and oblique incidence), Analysis of polarized Light. Nicol prism, Quarter wave plate and half wave plate, production and detection of (i) Plane polarized light (ii) Circularly polarized light and (iii) Elliptically polarized light. Qualitative idea of optical rotation and Polarimeters.	11

IV	**Lasers:** Basic concept of absorption and emission of radiations, amplification and population inversion; Main components of lasers: (i) Active Medium (ii) Pumping (iii) Optical Resonator; Properties of laser beam: Monochromaticity, Directionality, Intensity, Coherence (Spatial & Temporal coherence); Metastable state, Excitation mechanism and Types of Lasers (He-Ne Laser & Ruby Laser), Applications of Lasers	12
	Practicum 1 To determine Refractive index of the material of a prism using sodium source. 2 Determination of wave length of sodium light using Newton's Rings. 3 To determine the dispersive power and Cauchy constants of the material of a prism using Mercury discharge source. 4 To draw a graph between wave length and minimum deviation for various lines from a Mercury discharge source. 5 Determination of wavelength of sodium light by using a diffraction grating. 6 Resolving power of a telescope. 7 Resolving power of a prism. 8 Resolving power of a grating. 9 Comparison of Illuminating Powers by a Photometer. 10 Measurement of (a) Specific rotation (b) concentration of sugar solution using polarimeter. 11 Ordinary and extra ordinary refractive indices for calcite or quartz. 12 To find the equivalent focal length of a lens system by nodal slide assembly. **Note: Student will perform at least five experiments. The examiner will allot one practical at the time of end term examination.**	30
Suggested Evaluation Methods		
Internal Assessment: ➢ **Theory (20 Marks)** • Class Participation: **05 Marks** • Seminar/presentation/assignment/quiz/class test etc.: **05 Marks** • Mid-Term Exam: **10 Marks** ➢ **Practicum (10 Marks)** • Class Participation: **Nil** • Seminar/Demonstration/Viva-voce/Lab records etc.: **10 Marks** • Mid-Term Exam: **Nil**		**End Term Examination : 50 Marks** **20 Marks**
Part C-Learning Resources		

Recommended Books/e-resources/LMS:

1. Principles of Optics, M. Born and E. Wolf, Pergamaman Press
2. Optics by Ajoy Ghatak, 2008, Tata McGraw Hill
3. Fundamentals of Optics, Jenkins and White, McGraw Hill Book Co. Ltd., New Delhi
4. Optics, K.D. Muller, University Science Books, Mill ally California
5. An Introduction to Interferometery, Tolansky, John Wiley & Sons, New Delhi
6. Polarized Light Production and Use, Shurcliff, Harward University Press, Cambridge, M A (USA)
7. Lasers and Non-Linear Optics, B.B.Laud, New Age International (P) Ltd., Publishers, New Delhi
8. Lasers, Principles, Types and Applications, K.R. Nambiar, New Age International (P) Ltd., Publishers, New Delhi
9. Laser, Theory & Applications by K. Thyagarajan and A.K. Ghatak, Macmillan India limited
10. A textbook of optics by N. Subrahmanyam and Brijlal, S. Chand & Company
11. B.Sc. Practical Physics, C.L. Arora, S. Chand Publisher, New Delhi
12. Advanced Level Practical Physics, M. Nelkon and Ogborn, Henemann Education Books Ltd., New Delhi
13. Practical Physics, S.S. Srivastava and M.K. Gupta, Atma Ram & Sons, Delhi
14. Practical Physics, S.L. Gupta and V. Kumar, Pragati Prakashan Meerut
15. Modern Approach to Practical Physics, R.K. Singla, Modern Publishers, Jalandhar
16. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, Asia Publishing House

Ch. Ranbir Singh University, Jind
Undergraduate Programs
Course: MCC-7

Session: 2023-24	
Part A - Introduction	
Subject	Physics
Semester	4th
Name of the Course	**Introductory Quantum Mechanics**
Course Code	B23-PHY-402
Course Type: (CC/MCC/MDC/CC-M/ DSEC /VOC/DSE/PC/AEC/VAC)	MCC
Level of the course (As per Annexure-I	100-199
Pre-requisite for the course (if any)	Appeared or passed the 3rd sem (B.Sc. Physical Science(H)/ equivalent)
Course Learning Outcomes(CLO):	After completing this course, the learner will be able to: 1. Know main aspects of the inadequacies of classical mechanics and understand historical development of quantum mechanics and understand the theory of quantum measurements, wave packets and uncertainty principle. 2. Understand the central concepts of quantum mechanics: wave functions, Interpretation of Wave Function, momentum and energy operator, expectation values, the Schrodinger equation, time dependent and time independent cases, probability density, the normalization techniques, Eigen functions, Eigen values and their significance. 3. Understanding the behavior of quantum particle encountering the (i) barrier & ii) potential. 4. Solve Schrodinger equation for ground state energy and wave functions of various simple quantum mechanical one dimensional and three dimensional potentials 5. Learn to present observations, results, analysis and different concepts related to experiments of Elements of Quantum Mechanics.

Credits	Theory	Practical	Total
	3	1	4
Contact Hours	3	2	5
Max. Marks:100 **Internal Assessment Marks:30** **End Term Exam Marks: 70**		**Time:3hrs**	

Part B- Contents of the Course

Instructions for Paper- Setter

1. Nine questions will be set in total.

2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.

3. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.

4. 20% numerical problems are to be set.

5. Use of scientific (non-programmable) calculator is allowed.

Unit	Topics	Contact Hours
I	**THE ORIGIN QUANTUM PHYSICS I** Inadequacies in Classical Physics, Overview of quantum physics, boundary between classical and quantum phenomena**,** Blackbody Radiation, Planck's Quantum Theory, Photons, Photoelectric effect, Compton effect (theory and result), Bohr model of atom. Frank-Hertz experiment, de- Broglie hypothesis, Davisson and Germer experiment. Problem with de Broglie hypothesis.	11
II	**THE ORIGIN QUANTUM PHYSICS I** Concept of wave packet, phase velocity, group velocity and their relation. Heisenberg's uncertainty principle. Time energy and angular momentum, position uncertainty. Uncertainty principle from de Broglie wave. (Wave-particle duality), Uncertainty principle from the Gamma Ray Microscope. Uncertainty principle from electron diffraction due to single slit.	10
III	**THE SCHRODINGER WAVE EQUATION** Time dependent and time independent Schrodinger equation, dynamical evolution of a quantum state; properties of Wave Function, Interpretation of Wave Function, Condition for physical acceptability of Wave Functions. Eigenvalues and Eigen functions, Mathematical consideration of Schrodinger equation: Normalization, Orthogonality, Observables, Stationary states, Position, Linear momentum & Energy operators; commutator of position and linear momentum operators; Probability current density, Expectation values	12

	of position and linear momentum	

IV	**APPLICATION OF SCHRODINGER WAVE EQUATION** (i) Free particle in one-dimensional box (solution of Schrodinger wave equation, eigen functions, eigen values, quantization of energy and momentum, nodes and anti-nodes, zero point energy). (ii) One dimensional step potential E > Vo (Reflection and Transmission coefficient) (iii) One dimensional step potential E < Vo (penetration depth calculation). (iv) One dimensional potential barrier, E > Vo (Reflection and Transmission coefficient) (v) One-dimensional potential barrier, E < Vo (penetration or tunneling coefficient) (VI) Solution of Schrodinger equation for harmonic oscillator (quantization of energy, Zero-point energy, wave equation for ground state and excited states).	12
	<u>Practicum</u> 1. To find the specific heat of a solid by a method of mixture. 2. To find the specific heat of a liquid (Turpentine oil) by law of cooling. 3. To find coefficient of apparent expansion of glycerine 4. Study of Electron spin resonance- determine magnetic field as a function of the resonance frequency 5. Study of Zeeman effect: with external magnetic field; Hyperfine splitting 6. To study the quantum tunnelling effect with solid state device, e.g. tunnelling current in backward diode or tunnel diode. 7. Determination of Planck's Constant Using the Photoelectric Effect. 8. Determination of work function Using the Photoelectric Effect. 9. To demonstrate the concept of quantisation of the energy levels according to the Bohr's model of an atom. 10. Study of excitations of a given atom by Franck Hertz set up. 11. To determine the ionization potential of mercury 12. Study of Arc emission spectrum of given samples (Fe and Cu). 13. Determination of e/m of an electron by Helical method. 14. Determination of e/m of an electron by Thomson method **Note: Student will perform at least five experiments. The examiner will allot one practical at the time of end term examination.**	30
Suggested Evaluation Methods		

Internal Assessment: ➢ **Theory (20 Marks)** • Class Participation: **05 Marks** • Seminar/presentation/assignment/quiz/class test etc.: **05 Marks** • Mid-Term Exam: **10 Marks** ➢ **Practicum (10 Marks)** • Class Participation: **Nil** • Seminar/Demonstration/Viva-voce/Lab records etc.: **10 Marks** • Mid-Term Exam: **Nil**	**End Term Examination : 50 Marks** **20 Marks**

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Quantum Mechanics, Leonard I. Schiff , 3rd Edn 2010, Tata McGraw Hill.
2. A Text book of Quantum Mechanics, P.M. Mathews and K. Venkatesan, 2nd Edn, 2010, McGraw Hill.
3. A. Ghatak & S. Lokanathan, Quantum Mechanics: Theory and Applications, 5th Edition, (Macmillan India , 2004)
4. Quantum Mechanics, Robert Eisberg and Robert Resnick, 2nd Edn, 2002, Wiley.
5. Quantum Mechanics, G. Aruldhas, 2nd Edn 2002, PHI Learning of India.
6. Quantum Mechanics, B.H. Bransden and C.J. Joachain, Pearson Education, New Delhi.
7. Introductory Quantum Mechanics, David J. Griffith, 2nd Ed. 2005, Pearson Education.
8. Quantum Physics of Atoms Molecules, Solids, Nuclei and Particles, R.M. Eisberg and R. Resnick, Wiley Eastern Ltd, New Delhi
9. Quantum Mechanics, G R Chatwal and S K Anand, Himalaya Publishing House, New Delhi
10. Quantum Physics(Berkeley Physics Course), E H Witchman, Tata McGraw Hill, Chennai
11. B.Sc. Practical Physics, C.L. Arora, S. Chand Publisher, New Delhi
12. Advanced Level Practical Physics, M. Nelkon and Ogborn, Henemann Education Books Ltd., New Delhi
13. Practical Physics, S.S. Srivastava and M.K. Gupta, Atma Ram & Sons, Delhi
14. Practical Physics, S.L. Gupta and V. Kumar, Pragati Prakashan Meerut

Ch. Ranbir Singh University, Jind
Undergraduate Programs
Course: MCC-8

Session: 2023-24			
Part A - Introduction			
Subject	Physics		
Semester	4th		
Name of the Course	**Atomic spectroscopy**		
Course Code	B23-PHY-403		
Course Type: (CC/MCC/MDC/CC-M/ DSEC /VOC/DSE/PC/AEC/VAC)	MCC		
Level of the course (As per Annexure-I	100-199		
Pre-requisite for the course (if any)	Appeared or passed the 3rd sem (B.Sc. Physical Science (H)/ equivalent)		
Course Learning Outcomes(CLO):	After completing this course, the learner will be able to: 1. Acquire knowledge about the historical background and developments of atomic spectroscopy through the study of spectral series in Hydrogen atom, effect of nuclear motion on line spectra (correction of finite nuclear mass), short comings of Bohr's theory, Wilson sommerfeld quantization rule, Sommerfeld's extension of Bohr's model, Sommerfeld relativistic correction, Short comings of Bohr-Sommerfeld theory and finally Vector atom model 2. Understand and explain the vector atom model, various coupling schemes and atomic spectra of one and two electron atoms 3. Understand the LS & JJ coupling 4. Explain the influence on the spectra of atoms in the presence of external applied electric and magnetic field i.e. Zeeman effect, Paschen-Back effect, Stark effect 5. Learn to present observations, results, analysis and different concepts related to experiments of Elements of Atomic and Molecular Physics.		
Credits	Theory	Practical	Total

	3	1	4
Contact Hours	3	2	5
Max. Marks:100 **Internal Assessment Marks:30** **End Term Exam Marks: 70**		**Time:3hrs**	

Part B- Contents of the Course

Instructions for Paper- Setter

1. Nine questions will be set in total.

2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.

3. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.

4. 20% numerical problems are to be set.

5. Use of scientific (non-programmable) calculator is allowed.

Unit	Topics	Contact Hours
I	**Historical background of atomic spectroscopy:** Introduction of early observations, emission and absorption spectra, atomic spectra, wave number, Bohr atomic model(Bohr's postulates) , spectra of Hydrogen atom , explanation of spectral series in Hydrogen atom, un-quantized states and continuous spectra, spectral series in absorption spectra, effect of nuclear motion on line spectra (correction of finite nuclear mass), variation in Rydberg constant due to finite mass, short comings of Bohr's theory, Vector atom model**;** space quantization, electron spin, coupling of orbital and spin angular momentum, spectroscopic terms and their notation, quantum numbers associated with vector atom model, transition probability and selection rules.	11
II	**Vector atom model (single valance electron):** Orbital magnetic dipole moment (Bohr megnaton), behavior of magnetic dipole in external magnetic field; Larmor's precession and Larmor's theorem. Penetrating and Non-penetrating orbits, Penetrating orbits on the classical model**;** Quantum defect, spin orbit interaction energy of the single valance electron. Hydrogen fine spectra, Main features of Alkali Spectra and their theoretical interpretation, term series and limits, Rydeburg-Ritze combination principle, Absorption spectra of Alkali atoms. observed doublet fine structure in the spectra of alkali metals and its Interpretation, Intensity rules for doublets, comparison of Alkali spectra and Hydrogen spectrum	12
III	**Vector atom model (two valance electron):** Essential features of spectra of Alkaline-earth elements, Vector model for two valance electron atom: application of spectra. Coupling Schemes;LS or Russell – Saunders Coupling Scheme and JJ coupling scheme, Interaction energy in L-S coupling (sp, pd configuration), Lande interval rule, Pauli principal and	12

	periodic classification of the elements. Interaction energy in JJ Coupling (sp, pd configuration), equivalent and non-equivalent electrons, Two valance electron system-spectral terms of non-equivalent and equivalent electrons, comparison of spectral terms in L-S And J-J coupling. Hyperfine structure of spectral lines and its origin; isotope effect, nuclear spin	
IV	**Atom in external field:** Zeeman Effect (normal and Anomalous),Experimental set-up for studying Zeeman effect, Explanation of normal Zeeman effect(classical and quantum mechanical), Explanation of anomalous Zeeman effect(Lande g-factor), Zeeman pattern of D1 and D2 lines of Na-atom, Paschen-Back effect of a single valence electron system. Weak field Stark effect of Hydrogen atom.	10
	<u>Practicum</u> 1. To determine the value of Boltzmann Constant by studying Forward Characteristics of a Diode. 2. To determine the value of Planck's Constant by using four different LEDs. 3. To determine the value of e/m by (a) Magnetic Focussing or (b) Bar Magnet. 4. To determine the wavelengths of Hydrogen spectrum and hence to determine the value of Rydberg's Constant. 5. To determine the Wavelength of H-alpha Emission Line of Hydrogen Atom. 6. To determine the Wavelength and the Angular Spread of a He-Ne Laser. 7. To determine the value of Stefan's Constant. 8. To determine the Wavelength and the Velocity of Ultrasonic Waves in a liquid (Kerosene Oil, Xylene, etc.) by studying the Diffraction of light through an Ultrasonic Grating 9. To estimate the temperature of Sodium flame by studying the reversal of spectral lines (D lines). 10. To study the characteristics of LASER. **Note: Student will perform at least five experiments. The examiner will allot one practical at the time of end term examination.**	30
Suggested Evaluation Methods		
Internal Assessment: ➢ **Theory (20 Marks)** • Class Participation: **05 Marks** • Seminar/presentation/assignment/quiz/class test etc.: **05 Marks** • Mid-Term Exam: **10 Marks** ➢ **Practicum (10 Marks)** • Class Participation: **Nil** • Seminar/Demonstration/Viva-voce/Lab records etc.: **10 Marks** • Mid-Term Exam: **Nil**		**End Term Examination : 50 Marks** **20 Marks**
Part C-Learning Resources		

Recommended Books/e-resources/LMS:

1. Concept of Modern Physics (1987), A. Beiser, Mc Graw Hill Co Ltd. New Delhi
2. Atomic Physics (2007), J.B. Rajab, S Chand & Co, New Delhi
3. Atomic Physics Vol II (1991), J.H. Fewkes and J. Yarwood, Oxford University Press
4. Physics of Atoms and Molecules 2nd Ed (2009), B.H.Bransden and C.J. Joachain, Pearson Education, New Delhi
5. Fundamental of Molecular Spectroscopy,Colin N. Banwell and Elaine M. McCash, McGraw Hill Co Ltd. New Delhi
6. Atomic and Nuclear Physics Vol I (1996) S.N. Ghoshal, S. Chand & Com., New Delhi
7. Atomic and Nuclear Physics (1982), K. Gopalkrishnan, Mc Millan India, New Delhi
8. Elements of Spectroscopy S.L.Gupta, V. Kumar and R.C.Sharma, Pragati Prakashan, Meerut.
9. Geeta Sanon, BSc Practical Physics, 1st Edn. (2007), R. Chand & Co.
10. B. L. Worsnop and H. T. Flint, Advanced Practical Physics, Asia Publishing House, New Delhi.
11. Indu Prakash and Ramakrishna, A Text Book of Practical Physics, Kitab Mahal, New Delhi.
12. D. P. Khandelwal, A Laboratory Manual of Physics for Undergraduate Classes, Vani Publication House, New Delhi.
13. Nelson and Jon Ogborn, Practical Physics.

Ch. Ranbir Singh University, Jind
Undergraduate Programs
Course: DSE-1

<table>
<tr><th colspan="4">Session: 2023-24</th></tr>
<tr><th colspan="4">Part A - Introduction</th></tr>
<tr><td>Subject</td><td colspan="3">Physics</td></tr>
<tr><td>Semester</td><td colspan="3">4th</td></tr>
<tr><td>Name of the Course</td><td colspan="3">Laser Physics & Fiber Optics</td></tr>
<tr><td>Course Code</td><td colspan="3">B23-PHY-404</td></tr>
<tr><td>Course Type: (CC/MCC/MDC/CC-M/ DSEC /VOC/DSE/PC/AEC/VAC)</td><td colspan="3">DSE</td></tr>
<tr><td>Level of the course (As per Annexure-I</td><td colspan="3">100-199</td></tr>
<tr><td>Pre-requisite for the course (if any)</td><td colspan="3">Appeared or passed the 3rd sem (B.Sc. Physical Science (H)/ equivalent)</td></tr>
<tr><td>Course Learning Outcomes(CLO):</td><td colspan="3">After completing this course, the learner will be able to:
1. Understand the basic principle of laser, Einstein’s coefficients and their physical significance. Line broadening and its reasons
2. Qualitative understanding of different lasing mechanism, variation of output laser power around threshold and basic idea of oscillating of modes in laser cavity and their roles in propagation
3. Understand about optical fibres and its classification, basic principle involved in propagation of light through optical fibre and its application in communication
4. Have the idea of Fibre materials, Fibre Cables and Fabrication Techniques
5. Understand how and why to use of laser source in performing experiments in laboratory and have the idea how the signal that carries information transmitted through the optical fibre.</td></tr>
<tr><td rowspan="2">Credits</td><td>Theory</td><td>Practical</td><td>Total</td></tr>
<tr><td>3</td><td>1</td><td>4</td></tr>
<tr><td>Contact Hours</td><td>3</td><td>2</td><td>5</td></tr>
</table>

Max. Marks:100 **Internal Assessment Marks:30** **End Term Exam Marks: 70**	**Time:3hrs**

Part B- Contents of the Course

Instructions for Paper- Setter

1. Nine questions will be set in total.

2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.

3. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.

4. 20% numerical problems are to be set.

5. Use of scientific (non-programmable) calculator is allowed.

Unit	Topics	Contact Hours
I	**Introduction to Laser:** The Einstein Coefficients, Absorption and Emission cross-sections; Light amplification by an atomic system; Threshold condition; Origin of Line Shape function: Lorentzian and Gaussian shape functions; Line Broadening mechanisms - Homogeneous broadening: Natural Broadening, Collision broadening; Inhomogeneous broadening: Doppler Broadening	11
II	**Laser Rate Equations:** Two Level laser system, Three Level laser system, Four Level Laser Systems (Threshold Population, threshold pump rate, Laser power output with suitable examples), Variation of laser power around threshold; Optimum output coupling. Cavity modes: Number of modes in 1D, 2D and 3D cavities	12
III	**Optical fibres:** Introduction; step index fibre, numerical aperture, pulse dispersion in step index fibre, graded index, material dispersion. Comparison of step and graded index fibres Propagation of light in optical Fibres : Basic structure and optical path of an optical fibre, Modes of propagation, meridional and skew rays, number of modes and cut off parameters of fibres, Single mode propagation. Disadvantage of monomode and graded index multimode fibre	11
IV	**Fibre materials & Fabrication Techniques**: Glass fibre, plastic fibre, losses of fibres; bending losses, intrinsic fibre losses, scattering losses and absorption losses. Fibre Cables: Fibre cable construction, Strength member, cable tensile loading, Minimum bend radius, Losses incurred during installation of cables or during subscriber service, testing of cables, cable selection criteria. Outside vapour phase oxidation, vapour phase axial deposition, modified chemical vapour deposition	11
	Practicum **1.** To determine wavelength and angular divergence of LASER beam.	30

	2. Demonstration of Temporal coherence and measurement of wavelength of laser light using Michelson interferometer. **3.** Measurement of refractive index using Brewster angle. **4.** Febry-Parrot interferometer. **5.** Study of spectrum of iodine vapour and deduce force constant for the iodine molecule. **6.** To study modulation and demodulation (Amplitude and frequency). **7.** To study and perform Pulse Amplitude Modulation and Demodulation. **8.** To study and perform Pulse Width Modulation and Demodulation. **9.** To study and perform Pulse Position Modulation and Demodulation. **10.** To determine Numerical aperture and acceptance angle of a given optical fiber. **11.** Determination of diameter of wire using He-Ne Laser. **12.** Study double slit interference by He-Ne laser **13.** Determination of wavelength of He-Ne Laser by using a diffraction grating. **14.** To measure the numerical aperture of an optical fibre using He-Ne laser source. **Note: Student will perform at least six experiments. The examiner will allot one practical at the time of end term examination.**	

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory (20 Marks)** • Class Participation: **05 Marks** • Seminar/presentation/assignment/quiz/class test etc.: **05 Marks** • Mid-Term Exam: **10 Marks** ➢ **Practicum (10 Marks)** • Class Participation: **Nil** • Seminar/Demonstration/Viva-voce/Lab records etc.: **10 Marks** • Mid-Term Exam: **Nil**	**End Term Examination : 50 Marks** **20 Marks**

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Laser and Optical Engineering P.Das, Narosa Publication.
2. Lasers and Nonlinear Optics - B.B. Land.
3. Optical Electronics - A Ghatak and K. Thyagarayan.
4. Principles of Lasers, O. Svelto, Plenum (1989)
5. Laser Physics, L.V. Tarasov, Mir (1983)
6. Quantum Electronics, A.Yavir, John Wiley (1992)
7. Laser: Theory & Applications, A. Ghatak & K. Tayagrajan, Macmillan India
8. Optical fibre communication (second edition) - Gerd Keiser, McGraw Hill, Inc. New York.
9. Optical fibres and fibre optic communication systems - S.Sarkar.
10. Lasers: Principle, Typesand applications-K.R. Nambiar New Age International Publishers

Ch. Ranbir Singh University, Jind
Undergraduate Programs
Course: DSE-1

<table>
<tr><td colspan="4">Session: 2023-24</td></tr>
<tr><td colspan="4">Part A - Introduction</td></tr>
<tr><td>Subject</td><td colspan="3">Physics</td></tr>
<tr><td>Semester</td><td colspan="3">4th</td></tr>
<tr><td>Name of the Course</td><td colspan="3">Physics of Nanomaterials</td></tr>
<tr><td>Course Code</td><td colspan="3">B23-PHY-405</td></tr>
<tr><td>Course Type: (CC/MCC/MDC/CC-M/ DSEC /VOC/DSE/PC/AEC/VAC)</td><td colspan="3">DSE</td></tr>
<tr><td>Level of the course (As per Annexure-I</td><td colspan="3">100-199</td></tr>
<tr><td>Pre-requisite for the course (if any)</td><td colspan="3">Appeared or passed the 3rd sem (B.Sc. Physical Science (H)/ equivalent)</td></tr>
<tr><td>Course Learning Outcomes(CLO):</td><td colspan="3">After completing this course, the learner will be able to:
1. Understand the properties of Nanomaterials/ nanostructures
2. Understand the basic Physics of methods for preparation ofNanomaterials/nanostructures.
3. Understand the basic Physics of Characterization & Instrumentation Technique for Nanomaterials/ nanostructures.
4. Understand the application and advantages of Nanomaterials
5. Understand the analysis and plotting of experimental data using various techniques.</td></tr>
<tr><td rowspan="2">Credits</td><td>Theory</td><td>Practical</td><td>Total</td></tr>
<tr><td>3</td><td>1</td><td>4</td></tr>
<tr><td>Contact Hours</td><td>3</td><td>2</td><td>5</td></tr>
<tr><td colspan="2">Max. Marks:100
Internal Assessment Marks:30
End Term Exam Marks: 70</td><td colspan="2">Time:3hrs</td></tr>
<tr><td colspan="4">Part B- Contents of the Course</td></tr>
</table>

Instructions for Paper- Setter

1. Nine questions will be set in total.

2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.

3. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.

4. 20% numerical problems are to be set.

5. Use of scientific (non-programmable) calculator is allowed.

Unit	Topics	Contact Hours
I	Definition, Length scale, Historical background & developments, Richard Feynman Statement, Moore's law, Vision and objective of Nano-technology, Top down and Bottom up approach, Surface to Volume Ratio, Quantum confinement, Size effect in nano system, Quantum dots, Nanowires, Different Allotropes of carbon, Introduction to CNTs, Structure of CNTs, Types of CNTs- SWNTs, MWNTs, Bucky balls (C60), Graphene, Semiconductor Nano particles–types and properties.	10
II	**Synthesis methods for Nanomaterials/Nanostructures:** Bottom up and top down approaches for synthesis of nanomaterials, Synthesis of zero-dimensional nanostructures (Nanoparticles): Sol-Gel Process, Epitaxial core-shell nanoparticles, Ball milling, Synthesis of One-dimensional nanostructures (Nanowires, Nanorods, Nanotubes): Electrochemical deposition, Lithography, Synthesis of Two- dimensional nanostructures (Thin Films & Quantum wells): Molecular beam epitaxy (MBE), MOCVD, Cluster beam evaporation, Ion beam deposition.	12
III	**Characterization & Instrumentation Technique for Nanomaterials/Nanostructures**: X -ray Diffraction (XRD): Basic principle and idea of instrumentation, UV Visible spectroscopy: Basic principle and idea of instrumentation, Photoluminescence (PL) spectroscopy: Basic principle and idea of instrumentation, Raman spectroscopy: Basic principle and idea of instrumentation, Variations in Raman spectra of nanomaterials with particle size.	13
IV	**Applications of Nanomaterials:** Importance of nano-scale and technology, Applications of Nanotechnology in different field: Automobiles, Electronics and Devices, Nano-biotechnology, Materials, Medicine, Food, Textiles and Fabrics, Sporting Equipment and Goods, Chemical and Bio sensor, Enhancing Water Quality, Space Science, Improving Air Quality , IT sector, Environmental Remediation, agriculture; Advantages of Nanomaterials	10

	Practicum 1. To analyze the crystal structure of simple cubic, FCC and associated defects using XRD data. 2. To study the crystallite by W-H analysis of XRD data. 3. To study wavelength used by using standard FCC/BCC lattice in XRD. 4. To analyze the structural of different carbonaceous material (Quantum dot, CNT, grapheme, amorphous, graphite) using RAMAN spectroscopy data. 5. To study the RAMAN spectra of Polycarbonate monomer structure. 6. To study the band gap/energy gap of different materials using UV-visible spectroscopy data. 7. To study the Transmission spectra using UV-visible spectroscopy data. 8. To study the Absorption spectra using UV-visible spectroscopy data. 9. To study the band transition in different luminescent materials using PL spectroscopy data. 10. To study the emission and absorption spectra of a material using PL spectroscopy data. **Note: Student will perform at least five experiments. The examiner will allot one practical at the time of end term examination.**	30

Suggested Evaluation Methods	
Internal Assessment: ➢ **Theory (20 Marks)** • Class Participation: **05 Marks** • Seminar/presentation/assignment/quiz/class test etc.: **05 Marks** • Mid-Term Exam: **10 Marks** ➢ **Practicum (10 Marks)** • Class Participation: **Nil** • Seminar/Demonstration/Viva-voce/Lab records etc.: **10 Marks** • Mid-Term Exam: **Nil**	**End Term Examination : 50 Marks** **20 Marks**

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Nanotechnologies: The Physics of Nanomaterials Volume I, David S. Schmool.
2. Introduction to Nanoscience by Gabor L Hornyak and Joydeep Dutta
3. Nanophysics and Nanotechnology by Edward L Wolf
4. Essentials in Nano-science and nanotechnology by Narendra Kumar, Sunit Kumbhat
5. Nanostructures & Nanomaterials: Synthesis, Properties & Applications by Guozhong Cao
6. Nanotechnology: Principles and Practices by Sulabha K Kulkarni
7. Introduction to Nano: Basics to Nanoscience and Nanotechnology by Amretashis Sengupta and Chandan Kumar Sarkar.

Ch. Ranbir Singh University, Jind
Undergraduate Programs
Course: VAC-3

Session: 2023-24			
Part A - Introduction			
Subject	Physics		
Semester	3rd		
Name of the Course	**Indian Astronomy in the 18th and 19th Centuries**		
Course Code	PHY -VAC-316		
Course Type: (CC/MCC/MDC/CC-M/DSEC/ VOC/DSE/PC/AEC/VAC)	VAC		
Level of the course (As per Annexure-I	100-199		
Pre-requisite for the course (if any)			
Course Learning Outcomes(CLO):	After completing this course, the learner will be able to: 1. Understand the Classical Astronomy in India and Early astronomical measurements. 2. Understand the Growth and Development of Space and Radio Astronomy in India 3. Understand the Growth of Optical Astronomy in India 4. Understand the Astronomy in ancient, medieval and early telescopic era of India,		
Credits	Theory	Practical	Total
	2	NA	2
Contact Hours	2	NA	2
Max. Marks:50 **Internal Assessment Marks:15** **End Term Exam Marks: 35**		**Time:3hrs**	
Part B- Contents of the Course			

Instructions for Paper- Setter

1. Nine questions will be set in total.

2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.

3. Four more questions are to be attempted, selecting one question out of two questions set from

each unit. Each question may contain two or more parts. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	Classical Astronomy in India- Astronomy of the Vedas, Vedanga Jyotisa, Siddhantas- Famous Astronomers and Their Works, Aryabhata-I (b. 476 AD), Earth's Shape and Rotation, Post-Aryabhatan Astronomy, Indian Astronomers and Eclipses, Early astronomical measurements: Measurement of Earth's radius by Eratosthenes; Lunarand solar motion studies by Hipparchus - equinoxes and solstices, lunar and solar eclipses;	8
II	Aryabhatta-I and his seminal contributions to astronomy - relative motion, spinning Earth, eclipses, etc.; Varahamihira, Brahmagupta and other siddhantic astronomers of India; symbiotic relation between mathematics and astronomy; evidence of the precession of equinox from vedic literature; Jai Singh and his Jantar Mantar **Developments of Space Astronomy in India**-Satellite Experiments, Astrosat instruments,	7
III	**Growth and Development of Radio Astronomy in India-** Introduction, Radio Recombination Lines, The Gauribidanur T-array Radio Telescope, The Mauritius Radio Telescope, Pulsar Studies, Observations of Neutral Hydrogen Gas, Millimetre Wave Astronomy, Interplanetary Scintillations, Solar Wind and Solar Studies, Solar Radio Emission and Space Weather, Quasar and Pulsars	7
IV	**Growth of Optical Astronomy in India-** Birth of the Kodaikanal Observatory, Takhtasinghji Observatory and the Bhavnagar Telescope, Nizamiah Observatory, Post-war Development of Astronomy, Kodaikanal Observatory, The Vainu Bappu Observatory (VBO), Near-Infrared Astronomy, Udaipur Solar Observatory (USO)	8

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory (15 Marks)** • Class Participation: **4 Marks** • Seminar/presentation/assignment/quiz/class test etc.: **04 Marks** • Mid-Term Exam: **7 Marks**	**End Term Examination : 35 Marks**

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Astronomy in India: A Historical Perspective
2. The Story Of Astronomy In India by Chander Mohan
3. Indian Astronmy-An introduction by S Balachandra Rao Books

Ch. Ranbir Singh University, JindUndergraduate Programs

Course: VAC-3

Session: 2023-24			
Part A - Introduction			
Subject	Physics		
Semester	3rd		
Name of the Course	**Basics of Indian Astronomy**		
Course Code	PHY -VAC-318		
Course Type: (CC/MCC/MDC/CC-M/DSEC/ VOC/DSE/PC/AEC/VAC)	VAC		
Level of the course (As per Annexure-I	100-199		
Pre-requisite for the course (if any)			
Course Learning Outcomes(CLO):	After completing this course, the learner will be able to: 1. Understand the Astronomy and Astronomical Scales 2. Learn about the Astronomical Instruments, Astronomy in the Internet Age and Citizen Science Initiatives 3. Understand Sun and the solar family & Physics of Galaxies 4. Learn about the Astronomy in ancient, medieval and early telescopic era of India,		
Credits	Theory	Practical	Total
	2	NA	2
Contact Hours	2	NA	2
Max. Marks:50 **Internal Assessment Marks:15** **End Term Exam Marks: 35**		**Time:3hrs**	
Part B- Contents of the Course			

Instructions for Paper- Setter

1. Nine questions will be set in total.

2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.

3. Four more questions are to be attempted, selecting one question out of two questions set from

each unit. Each question may contain two or more parts. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**Introduction to Astronomy and Astronomical Scales:** History of astronomy, wonders of the Universe, overview of the night sky, diurnal and yearly motions of the Sun, size, mass, density and temperature of astronomical objects, basic concepts of positional astronomy: Celestial sphere, Astronomical coordinate systems, Horizon system and Equatorial system	7
II	**Astronomical Instruments:** Observing through the atmosphere (Scintillation, Seeing, Atmospheric Windows and Extinction). Basic optical definitions for telescopes: Magnification, Light Gathering Power, Limiting magnitude, Resolving Power, Diffraction Limit. Optical telescopes, radio telescopes, Hubble space telescope, James Web space telescope, Fermi Gamma ray space telescope. **Astronomy in the Internet Age:** Overview of Aladin Sky Atlas, Astrometrica, Sloan Digital Sky Survey, Stellarium, virtual telescope	8
III	**Sun and the solar family:** Solar parameters, Sun's internal structure, solar photosphere, solar atmosphere, chromosphere, corona, solar activity, origin of the solar system, the nebular model, tidal forces and planetary rings **Physics of Galaxies:** Basic structure and properties of different types of Galaxies, Nature of rotation of the Milky Way (Differential rotation of the Galaxy), Idea of dark matter	8
IV	**Astronomy in India:** Astronomy in ancient, medieval and early telescopic era of India, current Indian observatories (Hanle-Indian Astronomical Observatory, Devasthal Observatory, Vainu Bappu Observatory, Mount Abu Infrared Observatory, Gauribidanur Radio Observatory, Giant Metre- wave Radio Telescope, Udaipur Solar Observatory, LIGOIndia) (qualitative discussion), Indian astronomy missions (Astrosat, Aditya).	7

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory (15 Marks)** • Class Participation: **4 Marks** • Seminar/presentation/assignment/quiz/class test etc.: **04 Marks** • Mid-Term Exam: **7 Marks**	**End Term Examination : 35 Marks**

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. 1. Seven Wonders of the Cosmos, Jayant V Narlikar, Cambridge University Press
2. Fundamental of Astronomy, H. Karttunen et al. Springer
3. Modern Astrophysics, B.W. Carroll and D.A. Ostlie, Addison-Wesley Publishing Co.
4. Introductory Astronomy and Astrophysics, M. Zeilik and S.A. Gregory, Saunders College Publishing.
5. The Molecular Universe, A.G.G.M. Tielens (Sections I, II and III), Reviews of Modern Physics, Volume 85, July-September, 2013
6. Astronomy in India: A Historical Perspective, Thanu Padmanabhan, Springer
7. Textbook of Astronomy and Astrophysics with elements of cosmology, V.B.Bhatia, Narosa Publication
8. https://aladin.u-strasbg.fr/
9. http://www.astrometrica.at/
10. https://www.sdss.org/
11. http://stellarium.org/
12. https://www.zooniverse.org/projects/zookeeper/galaxy-zoo/
13. https://setiathome.berkeley.edu/
14. https://www.radathomeindia.org/

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Course: VAC-3

<table>
<tr><td colspan="4">Session: 2023-24</td></tr>
<tr><td colspan="4">Part A - Introduction</td></tr>
<tr><td>Subject</td><td colspan="3">Physics</td></tr>
<tr><td>Semester</td><td colspan="3">3rd</td></tr>
<tr><td>Name of the Course</td><td colspan="3">Exploring the Journey of Indian Space Satellites</td></tr>
<tr><td>Course Code</td><td colspan="3">PHY -VAC-326</td></tr>
<tr><td>Course Type: (CC/MCC/MDC/CC-M/DSEC/ VOC/DSE/PC/AEC/VAC)</td><td colspan="3">VAC</td></tr>
<tr><td>Level of the course (As per Annexure-I</td><td colspan="3">100-199</td></tr>
<tr><td>Pre-requisite for the course (if any)</td><td colspan="3"></td></tr>
<tr><td>Course Learning Outcomes(CLO):</td><td colspan="3">After completing this course, the learner will be able to:
1. Learn about the Concept, , ideas and theories of Satellite and Orbits.
2. Elementary understanding of Satellite Systems and their Applications.
3. Get the idea of Indian Communications satellites and their applications and Classification of Satellites.
4. Get knowledge about Milestones in India’s Space Programme.</td></tr>
<tr><td rowspan="2">Credits</td><td>Theory</td><td>Practical</td><td>Total</td></tr>
<tr><td>2</td><td>NA</td><td>2</td></tr>
<tr><td>Contact Hours</td><td>2</td><td>NA</td><td>2</td></tr>
<tr><td colspan="2">Max. Marks:50
Internal Assessment Marks:15
End Term Exam Marks: 35</td><td colspan="2">Time:3hrs</td></tr>
<tr><td colspan="4">Part B- Contents of the Course</td></tr>
<tr><td colspan="4"><u>Instructions for Paper- Setter</u>
1.Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.</td></tr>
</table>

3. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	Concept of Satellite, ideas and theories, Concept of Orbits, The transfer orbit, hurdles in launching a satellite, space scarcity in space. Indian pace program, Objectives of the Indian Space Program, Organizational set-up.	7
II	Communication Satellite: Orbit and Description: A brief History of Satellite Communication, Satellite Frequency bands, Satellite Systems, Applications, Orbital Period and Velocity, Effects of Orbital inclination, Azimuth and Elevation, Coverage and Slant range, Eclipse, Orbital perturbations , Placement of a Satellite in a Geo-Stationary Orbit	8
III	Space Centres and institutes, Genesis of Indian's space program, Indian Satellites, Indian Communications satellites and their applications. Classification of Satellites based on Orbit Height. Indian remote sensing satellites, Indian National Satellites	8
IV	Launch vehicle technology, Milestones in India's Space Programme.	7

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory (15 Marks)** • Class Participation: **4 Marks** • Seminar/presentation/assignment/quiz/class test etc.: **04 Marks** • Mid-Term Exam: **7 Marks**	**End Term Examination : 35 Marks**

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. https://www.indiascience.in/videos/isro-indias-space-journey-e-2
2. https://www.indiascience.in/videos/isro-indias-space-journey-part-2-e-1
3. https://www.insightsonindia.com/science-technology/space-technology/milestones-in-indias-space-programme/
4. https://www.clearias.com/indian-space-program/
5. SCIENCE 366: A Chronicle of Science and Technology, Basu Biman
6. Science and technology, Praveen Chandra Mishra, Chronicle Books

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Course: VAC-4

<table>
<tr><td colspan="4">Session: 2023-24</td></tr>
<tr><td colspan="4">Part A - Introduction</td></tr>
<tr><td>Subject</td><td colspan="3">Physics</td></tr>
<tr><td>Semester</td><td colspan="3">4th</td></tr>
<tr><td>Name of the Course</td><td colspan="3">Physics in Everyday Life</td></tr>
<tr><td>Course Code</td><td colspan="3">PHY -VAC-419</td></tr>
<tr><td>Course Type: (CC/MCC/MDC/CC-M/DSEC/ VOC/DSE/PC/AEC/VAC)</td><td colspan="3">VAC</td></tr>
<tr><td>Level of the course (As per Annexure-I</td><td colspan="3">100-199</td></tr>
<tr><td>Pre-requisite for the course (if any)</td><td colspan="3"></td></tr>
<tr><td>Course Learning Outcomes(CLO):</td><td colspan="3">After completing this course, the learner will be able to:
1. Elementary understanding of the mechanical concepts and application in daily life related to Force, weight, work, energy, power.
2. Get the idea of working of refrigerator, air conditioner, Bernoulli principle, pressure cooker.in various engines.
3. Learn about the daily life activities related to sound and optics.
4. Basic understanding some electrical and electronic appliances</td></tr>
<tr><td rowspan="2">Credits</td><td>Theory</td><td>Practical</td><td>Total</td></tr>
<tr><td>2</td><td>NA</td><td>2</td></tr>
<tr><td>Contact Hours</td><td>2</td><td>NA</td><td>2</td></tr>
<tr><td colspan="2">Max. Marks:50
Internal Assessment Marks:15
End Term Exam Marks: 35</td><td colspan="2">Time:3hrs</td></tr>
<tr><td colspan="4">Part B- Contents of the Course</td></tr>
<tr><td colspan="4"><u>Instructions for Paper- Setter</u>
6.Nine questions will be set in total.</td></tr>
</table>

7. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.

8. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**MECHANICS** Every day activities related to Force, weight, work, energy, power and centrifuge; washing machine.	7
II	**HEAT** Variation of boiling point with pressure, pressure cooker, cooling by expansion, refrigerator, air conditioner, Bernoulli principle – Bunsen burner, aeroplane	8
III	**SOUND AND OPTICS** Sound waves, Doppler Effect, power of lens, long sight and short sight, microscope, telescope, binocular camera, video camera.	8
IV	**ELECTRICAL AND ELECTRONIC APPLIANCES** Working of the tube light and fan, kilowatt hour, fuse and heating elements, microwave oven, electric heater, photoelectric effect.	7

Suggested Evaluation Methods

Internal Assessment: **Theory (15 Marks)** • Class Participation: **4 Marks** • Seminar/presentation/assignment/quiz/class test etc.: **04 Marks** • Mid-Term Exam: **7 Marks**	**End Term Examination : 35 Marks**

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. R. Murugeshan, Allied Physics I & II, S. Chand & Co, New Delhi (2006).
2. D.S. Mathur, Elements of properties of matter and acoustics, S. Chand & Company Ltd., New Delhi(2010)
3. R.Murugeshan, Properties of matter and acoustics, S. Chand & Co, New Delhi(2012)
4. Brijal&Dr.N. Subramanyan and P.S. Hemne, Heat and Thermodynamics, S. Chand & Co, New Delhi, (2004)
5. R. Murugeshan, Electricity, S. Chand & Co, New Delhi (2010)
6. R. Murugeshan and KiruthigaSivaprasath, Modern Physics, S. Chand & Co, New Delhi (2016)
7. N. Subramaniyam, Brijlal and M.N.Avadhanulu, A textbook of Optics S. Chand & Co, New Delhi (2012)

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Course: VAC-4

Session: 2023-24			
Part A - Introduction			
Subject	Physics		
Semester	4th		
Name of the Course	**Radiations Hazards**		
Course Code	PHY -VAC-423		
Course Type: (CC/MCC/MDC/CC-M/DSEC/ VOC/DSE/PC/AEC/VAC)	VAC		
Level of the course (As per Annexure-I	100-199		
Pre-requisite for the course (if any)			
Course Learning Outcomes(CLO):	After completing this course, the learner will be able to: 1. Understanding of the sources of Radiation exposure Realize the importance of radiation protection and safe disposal of radioactive 2. Get the idea of Basics of Radiation detectors. 3. Learn about Hidden hazards of various radiation sources in the daily life. 4. Basic understanding of Cares against Hidden hazards of radiations.		
Credits	Theory	Practical	Total
	2	NA	2
Contact Hours	2	NA	2
Max. Marks:50 **Internal Assessment Marks:15** **End Term Exam Marks: 35**		**Time:3hrs**	
Part B- Contents of the Course			

Instructions for Paper- Setter

1. Nine questions will be set in total.

2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.

3. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	Radiation and need for its measurement, Physical features of radiation, Conventional sources of radiations. Exposure to natural radiation: external to the body, Radiation from cosmic rays and solar radiation, Internal exposure to the body, Radioactivity arising from technological development: Possible health hazards from nuclear and laser radiations. Maximum permissible level of radiation. Radiation quantities and units of energy flux, energy influence, cross-section.	7
II	Biological effects of radiation: Dose response characteristics, Direct and indirect action, Acute effects, Delayed effects, Cumulative effect, Accidental exposure, Radiation induced chemical changes in tissues, Radiation protection procedures (diagnostics and therapy). Radioactive waste disposal and management: Type of radioactive waste, Airborne waste, Solid and liquid waste, Assessment of Hazard.	8
III	Hidden hazards of Non-Thermal Radiation, RF and microwave radiation, Non-Thermal Effects of Pulsed RF EMR, Power Line 50/60 Hz Electric and Magnetic Fields (EMFs), Airport Scanners, Occupational Exposure, Electricity**,** Non-Thermal Radiation, Cell phones, Cell Phone Towers, Wi-Fi, Smart meters, microwave oven.	8
IV	Basic radiation safety criteria, Protection from direct radiation, Energy deposition, Effect of distance and shielding, Protection from contamination, Preparation of a safe radiation area, Basic Cares against Hidden hazards, Exposure Controls, Designing of labs to reduce radiation hazards.	7

Suggested Evaluation Methods

Internal Assessment:

➢ **Theory (15 Marks)**

- Class Participation: **4 Marks**
- Seminar/presentation/assignment/quiz/class test etc.: **04 Marks**
- Mid-Term Exam: **7 Marks**

End Term Examination : 35 Marks

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. RF and Microwave Radiation Safety Handbook by Ronald Kitchen
2. Hidden Dangers 5G By Captain Jerry G. Flynn
3. Health Physics: Radiation-Generating Devices, Characteristics, and Hazards by Joseph John Bevelacqua
4. Basics of Radiation Protection for Everyday Use by Leonie Munro
5. Radiation Safety Officer's Handbook by Gunhild von Oertzen and Detlof von Oertzen
6. Physics for Radiation Protection: A Handbook (Second Edition) by James E. Martin

7. Atoms, Radiation, and Radiation Protection (3rd edition) James E. Turner
8. Radiation Protection: A guide for Scientists, Regulators and Physicians (4th Edition) by Jacob Shapiro
9. Introduction to Radiobiology and Radiation Dosimetery - F.H. Aurix, John Wiley.
10. Techniques of Radiation Dosimetery - Eds K. Mahesh and DR Vij Wiley Eastern Limited.
11. Nuclear Energy - Raymond L. Murray Pergamon Press, N.Y.