Durgapur Women's College

(Affiliated to Kazi Nazrul University)

Mahatma Gandhi Road

Durgapur-713209

DEPARTMENT OF PHYSICS

Lesson Plan (Academic Year: 2024-25)

Semester-I:

Course Name: Mechanics and General properties of Matter
(MJC-1)
Course Type: MJC -1
(Theory and Practical)
Credit: 5 (L-T-P: 3-0-4) Full Marks: 100
Course Code: BSCPHYMJ101

Course Learning Outcomes:

After the completion of course, the students will have ability to:

1. Understand vector calculus, classical mechanics of single as well as system of particles within the scope the Newtonian formulation.
2. Understand the dynamics of rigid body and concept of moment of inertia. Study of moment of inertia of different bodies and its applications.
3. Examine phenomena of simple harmonic motion and the distinction between undamped, damped and forced oscillations and the concepts of resonance and quality factor in a driven system.
4. Apply Kepler's laws to describe the motion of planets and satellite in circular orbit.
5. Study the properties of matter, response of the classical systems to external forces and their elastic deformation and its applications and comprehend the dynamics of Fluid and concept of viscosity and surface tension along with its applications

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Unit No.	Topic/Subtopic	Name of the Teacher	Method and Means of Teaching	Suggested Books/Journals/E-Content	No. of Hours Allotted to the Topic/ Subtopic in the entire Teaching Phase of 90 days in a Semester*
1	Vector triple product(review)	Dr. A. K.Kole	Lecture and Experiential learning	Mentioned Later	1
1	Derivatives of vectors, Gradient, Divergence, Curl of a vector field;	Dr. A. K.Kole			2
1	Vector integrations-line, surface and volume integration	Dr. A. K.Kole			2
1	Gauss' divergence theorem, Stoke's theorem, Green's theorem (statement only with simple applications);	Dr. A. K.Kole			1
1	Introduction to Orthogonal curvilinear Co-ordinate systems, unit vectors	Dr. A. K.Kole			1
1	Jacobian;	Dr. A. K.Kole			1
1	Special cases: plane, spherical and cylindrical co-ordinate systems; Infinitesimal line segment, area and volume elements in them.	Dr. A. K.Kole			2
2	Introduction to Inertial & Non-inertial reference frames; Velocity and Acceleration - tangential and normal components,	D. Banerjee			1
2	Radial and Cross-radial components; Newton's laws, Inertial frame, Work, Energy, Impulse of a force,	D. Banerjee			1
2	Freely falling bodies, Motion in a resistive medium	D. Banerjee			1
2	Projectile motion. Conservative force and concept of potential; Conservation of energy; Dissipative forces	D. Banerjee			1
2	Translation invariance and conservation of linear momentm; Central force & Conservation of angular momentum; Torque; Brief reference to fundamental forces in nature	D. Banerjee			2

3	Oscillations: Simple Harmonic Motion and its properties, energy of a simple harmonic oscillator	Dr. A. K.Kole			1
3	Damped oscillations: under damped, over-damped, and critically damped motion,	Dr. A. K.Kole			2
3	Forced Oscillations and Resonance,	Dr. A. K.Kole			2
3	Q factor and Sharpness;	Dr. A. K.Kole			1
3	Examples of Oscillators from various branches of physics	Dr. A. K.Kole			2
4	Kepler's laws, Newton's law of gravitation	Dr. A. K.Kole			1
4	Motion of satellites in circular orbit. Geosynchronous orbits.	Dr. A. K.Kole			1
5	Degrees of freedom, Centre of mass and Centre of gravity	Dr. A. K.Kole			1
5	Momentum, Angular momentum, Torque, Kinetic energy of a system of particles;	D. Banerjee			1
5	Conservation of linear momentum, angular momentum, and Energy for a system of particles;	D. Banerjee			1
5	Centre of mass motion and Centre of mass coordinate; Examples: two coupled harmonic oscillators,	D. Banerjee			1
5	two-body systems with (i) gravitaional, (ii) Coulomb interaction etc	D. Banerjee			1
6	Concept of rigid body, Euler's theorem, General motion of rigid bodies: Chasle's theorem,	D. Banerjee			1
6	Rotational motion about an axis, Moment of inertia, Radius of gyration,	D. Banerjee			1
6	Perpendicular and Parallel Axis Theorems; Moment of inertia of a uniform body-Solid and hollow cylinders, Solid and hollow spheres,	D. Banerjee			2
6	Rectangular plane, thin rod; Rotational energy, Conservation of energy, Work and Power,	D. Banerjee			1
6	Motion of a flywheel, Theory of compound pendulum- Bar and Kater's pendulum,	D. Banerjee			1
6	Foucault Pendulum; determination of "g"; Principal axis and Product of Inertia; Rotating Cordinate & Coriolis force	D. Banerjee			1
7	Elasticity: Relation between different elastic moduli and Poisson's ratio,	D. Banerjee			1
7	Torsional pendulum, Bending of beam	D. Banerjee			1

7	Surface Tension: Angle of contact, surface tension and surface energy,	D. Banerjee			1
7	pressure difference across curved surface example, excess pressure inside spherical liquid drop	D. Banerjee			1
7	Viscocity: Streamline flow, turbulent flow, equation of continuity, determination of coefficient of viscosity by Poiseulle's method	D. Banerjee			2
7	Stoke's method. Bernoulli's theorem and its applications	D. Banerjee			1

Suggested Books /Journals/E-Content

1) *Vector Analysis - M. R. Spiegel, (Schaum's Outline Series) (Tata McGraw-Hill)*
2) *Classical Mechanics – J. C. Upadhyay, (Himalaya Publ.).*
3) *Introduction to Classical Mechanics - R. G. Takwale and P. S. Puranik (Tata McGraw-Hill).*
4) Theoretical Mechanics - M. R. Spiegel, (Schaum's Outline Series) (McGraw-Hill).
5) Berkeley Physics Course, Vol – I (Mechanics) (Mc Graw Hill).
6) Advanced Accoustics- D. P. Raychaudhury.
7) Waves and Oscillations by N K Bajaj
8) Waves and Oscillations by R. N. Chowdhury
9) An Introduction to Mechanics by Kleppner and Kolenkow
10) Classical Mechanics by Rana Joag
11) Introduction to classical Mechanics with problems and solutions by Davis Morin, Cambridge University Press
12) Feynman Lectures Vol. 1, R. P. Feynman, R. B. Leighton, M. Sands, 2008, Pearson Education
13) Elements of properties of matter by D.S. Mathur
14) A Treatise on general properties of matter by Sengupta and Chatterjee

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Semester-I:

Mechanics and General properties of Matter

(MNC-1)

Course Type: MNC-1

(Theory and Practical)

Credit: 5 (L-T-P: 3-0-4) Full Marks: 100

Course Code: BSCPHYMN101

Course Learning Outcomes:

After the completion of course, the students will have ability to:

1.Understand vector calculus, classical mechanics of single as well as system of particles within the scope the Newtonian formulation.

2. Understand the dynamics of rigid body and concept of moment of inertia. Study of moment of inertia of different bodies and its applications.

3. Examine phenomena of simple harmonic motion and the distinction between undamped, damped and forced oscillations and the concepts of resonance and quality factor in a driven system.

4. Apply Kepler's laws to describe the motion of planets and satellite in circular orbit.

5. Study the properties of matter, response of the classical systems to external forces and their elastic deformation and its applications and comprehend the dynamics of Fluid and concept of viscosity and surface tension along with its applications.

Unit No.	Topic/Subtopic	Name of the Teacher	Method and Means of Teaching	Suggested Books/Journals/E-Content	No. of Hours Allotted to the Topic/ Subtopic in the entire Teaching Phase of 90 days in a Semester*
1	Vector triple product(review)	A. Dawn	Lecture and Experiential	Mentioned Later	1

			learning		
1	Derivatives of vectors, Gradient, Divergence, Curl of a vector field;	A. Dawn			2
1	Vector integrations-line, surface and volume integration	A. Dawn			2
1	Gauss' divergence theorem, Stoke's theorem, Green's theorem (statement only with simple applications);	A. Dawn			1
1	Introduction to Orthogonal curvilinear Co-ordinate systems, unit vectors	A. Dawn			1
1	Jacobian;	A. Dawn			1
1	Special cases: plane, spherical and cylindrical co-ordinate systems; Infinitesimal line segment, area and volume elements in them.	A. Dawn			2
2	Introduction to Inertial & Non-inertial reference frames; Velocity and Acceleration - tangential and normal components,	A. Dawn			1
2	Radial and Cross-radial components; Newton's laws, Inertial frame, Work, Energy, Impulse of a force,	A. Dawn			1
2	Freely falling bodies, Motion in a resistive medium	A. Dawn			1
2	Projectile motion. Conservative force and concept of potential; Conservation of energy; Dissipative forces	A. Dawn			1
2	Translation invariance and conservation of linear momentm; Central force & Conservation of angular momentum; Torque; Brief reference to fundamental forces in nature	A. Dawn			2
3	Oscillations: Simple Harmonic Motion and its properties, energy of a simple harmonic oscillator	S. Sarkar			1
3	Damped oscillations: under damped, over-damped, and critically damped motion,	S. Sarkar			2
3	Forced Oscillations and Resonance,	S. Sarkar			2
3	Q factor and Sharpness;	S. Sarkar			1
3	Examples of Oscillators from various branches of physics	S. Sarkar			2
4	Kepler's laws, Newton's law of gravitation	A. Dawn			1
4	Motion of satellites in circular orbit. Geosynchronous orbits.	A. Dawn			1
5	Degrees of freedom, Centre of mass and Centre of gravity	A. Dawn			1
5	Momentum, Angular momentum, Torque, Kinetic energy of a system of	A. Dawn			1

	particles;				
5	Conservation of linear momentum, angular momentum, and Energy for a system of particles;	A. Dawn			1
5	Centre of mass motion and Centre of mass coordinate; Examples: two coupled harmonic oscillators,	A. Dawn			1
5	two-body systems with (i) gravitaional, (ii) Coulomb interaction etc	A. Dawn			1
6	Concept of rigid body, Euler's theorem, General motion of rigid bodies: Chasle's theorem,	S. Sarkar			1
6	Rotational motion about an axis, Moment of inertia, Radius of gyration,	S. Sarkar			1
6	Perpendicular and Parallel Axis Theorems; Moment of inertia of a uniform body-Solid and hollow cylinders, Solid and hollow spheres,	S. Sarkar			2
6	Rectangular plane, thin rod; Rotational energy, Conservation of energy, Work and Power,	S. Sarkar			1
6	Motion of a flywheel, Theory of compound pendulum- Bar and Kater's pendulum,	S. Sarkar			1
6	Foucault Pendulum; determination of "g"; Principal axis and Product of Inertia; Rotating Cordinate & Coriolis force	S. Sarkar			1
7	Elasticity: Relation between different elastic moduli and Poisson's ratio,	S. Sarkar			1
7	Torsional pendulum, Bending of beam	S. Sarkar			1
7	Surface Tension: Angle of contact, surface tension and surface energy,	S. Sarkar			1
7	pressure difference across curved surface example, excess pressure inside spherical liquid drop	S. Sarkar			1
7	Viscocity: Streamline flow, turbulent flow, equation of continuity, determination of coefficient of viscosity by Poiseulle's method	S. Sarkar			2
7	Stoke's method. Bernoulli's theorem and its applications	S. Sarkar			1

Suggested Books /Journals/E-Content

1) *Vector Analysis - M. R. Spiegel, (Schaum's Outline Series) (Tata McGraw-Hill)*
2) *Classical Mechanics – J. C. Upadhyay, (Himalaya Publ.).*

3) *Introduction to Classical Mechanics - R. G. Takwale and P. S. Puranik (Tata McGraw-Hill).*
4) Theoretical Mechanics - M. R. Spiegel, (Schaum's Outline Series) (McGraw-Hill).
5) Berkeley Physics Course, Vol – I (Mechanics) (Mc Graw Hill).
6) Advanced Accoustics- D. P. Raychaudhury.
7) Waves and Oscillations by N K Bajaj
8) Waves and Oscillations by R. N. Chowdhury
9) An Introduction to Mechanics by Kleppner and Kolenkow
10) Classical Mechanics by Rana Joag
11) Introduction to classical Mechanics with problems and solutions by Davis Morin, Cambridge University Press
12) Feynman Lectures Vol. 1, R. P. Feynman, R. B. Leighton, M. Sands, 2008, Pearson Education
13) Elements of properties of matter by D.S. Mathur
14) A Treatise on general properties of matter by Sengupta and Chatterjee

SEMESTER-I
MD COURSE
PHYSICAL SCIENCE
COURSE CODE: MDC101
Course Type: MDC-1 Course Details: Physical Science L-T-P: 3-0-0
Credit: 3 Full Marks: 50

Learning objectives:

1) On completion of this course students should be able to demonstrate a comprehensive understanding of the fundamental concepts of matter, energy, gravity, and space, as well as their applications in various fields including medicine, communication, and modern storage technology.
2) Students will also be able to critically analyze the universe's structure and evolution based on the Big Bang theory.
3) Additionally, they should have an awareness of the role of physics in everyday life and technological advancements.

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Unit No.	Topic/Subtopic	Name of the Teacher	Method and Means of Teaching	Suggested Books/Journals/E-Content	No. of Hours Allotted to the Topic/ Subtopic in the entire Teaching Phase of 90 days in a Semester*
1	What is matter? Constituents of matter (upto elementary particles), States of Matter, Fundamental forces in Nature	A. K.Kole	Lecture Based Teaching	Mentioned Later	3
1	What is energy?, Types of energy, Conservation of energy dissipation of energy,	A. K.Kole			3
1	Conversion of one form of energy to another, Equivalence of matter and energy	A. K.Kole			3
1	, energy generation and distribution in our daily life (Nuclear reactors, electrical energy)	A. K.Kole			3
1	Renewable and Non-renewable sources of energy; Solar energy, tidal energy, hydro energy	A. K.Kole			3
2	The force of Gravity; Planetary motion, Newton's third law	A. K.Kole			3
2	Weightlessness; Low earth orbit; Geosynchronous satellites; Spy satellites	S.Sarkar			3
2	Medium Earth Orbit satellite; Circular Acceleration; momentum	S.Sarkar			2
2	Rockets; Airplanes,	S.Sarkar			1
2	helicopters and fans; Hot air and helium balloons	S.Sarkar			2
2	Structure of the Universe (Milkyway, solar system, planets, comets)	S.Sarkar			3
2	Evolution of the Universe (Big Bang theory)	S.Sarkar			1
3	Medical Physics: stethoscope, x-ray,	A. K.Kole			2

3	Ultrasound, Laser, Endoscopy,	A. K.Kole			2
3	Colonoscopy, NMR,				2
3	Pet-scan, Radiation- radiation hazards and safety	S.Sarkar			2
3	Communication: optical communication, radars, broad-band, mobile communication	S.Sarkar			2
3	Modern storage system: magnetic storage, solid state devices	S.Sarkar			3
	holography	A. K.Kole			3

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Semester-III

MJC-3, Mathematical Methods of Physics

(BSCPHYMJ301, 60 Hrs)

Credit: 5 (4-1-0). F.M: 100 (30+70)

Course Learning Outcomes:

After the completion of course, the students will have ability to:

Course outcome: Students will have achieved the ability to:

1. Use concepts of calculus and concepts of random variables
2. Solve differential equations of various types.
3. Describe special functions and their recurrence relations
4. Do fourier expansion and use Fourier transforms and delta function
5. evaluate some special integrals

Unit No.	Topic/Subtopic	Name of the Teacher	Method and Means of Teaching	Suggested Books/Journals/E-Content	No. of Hours Allotted to the Topic/ Subtopic in the entire Teaching Phase of 90 days in a Semester*
1	Infinite sequences and series; Conditional and Absolute Convergence; Tests for Convergence (proofs not required), Functions of several real variables - partial differentiation, Constrained Maximization using Lagrange Multipliers.	A.K.Kole	Lecture Based Teaching		8
2	Random variables - joint and conditional probabilities,; Moments -	A.K.Kole	Lecture Based		6

	mean, variance, skewness and curtosis, Examples of continuous probability distribution functions (Binomial, Gaussian, and Poisson). Citation of simple examples from Physics.		Teaching		
3	Basic idea of matrix algebra , Rank of a matrix; Solution of simultaneous equation of matrices by Cramer's rule; Solution of systems of linear homogenous and inhomogeneous equations by matrix method; Cayley-Hamilton theorem; Characteristics equation for a square matrix and diagonalization; Properties of Eigenvalues and eigenvectors of matrices; Symmetric, Skew- symmetric, Hermitian, Orthogonal and Unitary matrices and their properties.	D. Banerjee	Lecture Based Teaching		12
4	Classifications of singularities for a Second Order Ordinary Differential Equation (ODE) - Fuchs' theorem; Series Solution of second order ODE with variable coefficients by Frobenius-Fuchs" method; Solutions of Legendre, Bessel and Hermite ODE. about x=0.	D.Banerjee	Lecture Based Teaching		8
5	Partial Differential Equations in Physics; Types – elliptical, hyperbolic and parabolic (examples from Physics), Solutions by separation of variables method; Basic examples- Laplace's equation, Diffusion equation, Wave equation. Solution of Laplace's equation in Cartesian, spherical polar (spherically symmetric cases), and cylindrical polar (cylindrically symmetric problems) coordinate systems.	S.Sarkar	Lecture Based Teaching		8
6	Properties of Legendre Polynomials: Rodrigues Formula, Generating Function. Simple recurrence relations. Expansion of function in a series of Legendre Polynomials. Bessel Functions of the First Kind: Generating Function, simple recurrence relations. Zeros of Bessel Functions and Orthogonality.	S.Sarkar	Lecture Based Teaching		8
7	Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions.	S.Sarkar	Lecture Based Teaching		3

8	(a) Periodic functions in Physics, Dirichlet Conditions (Statement only). Wronskian of two functions - linear independence and completeness, orthogonality; Fourier series expansion of periodic functions in terms of sine and cosine as basis, Calculation of Fourier coefficients in some simple cases, Complex representation of Fourier series. Expansion of non-periodic functions, Even and odd functions as special cases. Applications in Physics – vibration of string. (b) Introduction of Fourier transform as Fourier series of infinite period, propeties of Fourier transform, Inverse Fourier transform, Parseval Identity. Dirac delta function and its important properties.	A.K.Kole	Lecture Based Teaching		7

References/ Suggested Readings

1. Mathematical Methods in the Physical Sciences, Mary L. Boas
2. Essential Mathematical Methods for Physicists by Hans J. Weber and George B. Arfken
3. Introduction to Mathematical Physics - C. Harper (Prentice-Hall of India).
4. Mathematical Physics by Binoy Bhattacharya
5. Mathematical Physics by D. Biswas
6. Mathematical Physics by B S Grewal
7. Vector Analysis - M. R. Spiegel, (Schaum's Outline Series) (Tata McGraw-Hill).
8. Mathematical Physics – P.K. Chattopadhyay (Wiley Eastern)
9. Vector Analysis - M. R. Spiegel, (Schaum's Outline Series) (Tata McGraw-Hill)
10. Mathematical Methods for Physicists: Arfken, Weber, 2005, Harris, Elsevier.
11. Fourier Analysis by M.R. Spiegel, 2004, Tata McGraw-Hill.
12. Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole.
13. Differential Equations, George F. Simmons, 2006, Tata McGraw-Hill.

14. Partial Differential Equations for Scientists & Engineers, S.J. Farlow, 1993, Dover Pub.
15. Mathematical methods for Scientists & Engineers, D.A. McQuarrie, 2003, Viva Books Mathematical Physics by Binoy Bhattacharya
16. Mathematical Physics by D. Biswas
17. Mathematical Physics by B S Grewal
18. Introduction to Numerical Analysis, S.S. Sastry, 5th Edn. , 2012, PHI Learning Pvt. Ltd.
19. Schaum's Outline of Programming with C++. J. Hubbard, 2000, McGraw-Hill Pub.
20. Numerical Recipes in C: The Art of Scientific Computing, W.H. Pressetal, 3rd Edn., 2007, Cambridge University Press.
21. Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3rd ed., 2006,Cambridge University Press.

SEMESTER-III

Course type: **MAJOR- MJC-4**

Course code: **BSCPHYMJ302**

Course details: **OPTICS**

Course Type: MJC-4
Course Details: OPTICS
L-T-P: 3-0-4

Course Objective:-

This course reviews the concepts of waves and optics learnt at school from a more advanced perspective and goes on to build new concepts. It begins with explaining ideas of lens and different types of optical devices. The course also provides an in depth understanding of wave phenomena of light, namely, interference, diffraction and polarization with emphasis on practical applications of the same.

Course Learning Outcomes:

On successfully completing the requirements of this course, the students will have the skill and knowledge to:

• Understand Interference as superposition of waves from coherent sources derived from same parent source.
• Demonstrate basic concepts of Diffraction: Superposition of wavelets diffracted from aperture, understand Fraunhoffer and Fresnel Diffraction.

• In the laboratory course, student will gain hands-on experience of using various optical instruments and making finer measurements of wavelength of light using Newton Rings experiment, Fresnel Biprism etc.

Unit No.	Topic/Subtopic	Name of the Teacher	Method and Means of Teaching	Suggested Books/Journals/E-Content	No. of Hours Allotted to the Topic/ Subtopic in the entire Teaching Phase of 90 days in a Semester*
1	Concept of ray, ray optics limit, geometrical and optical path, Fermat's Principle, Principle of least path and extremum paths- example of extremum path. Aplanatic surface, Application to laws of reflection and refraction for a) plane surface and b) spherical surface. Application to determine lens formula	A. K.Kole	Lecture Based & Experiential Learning	Mentioned later	4
2	Translation, refraction and reflection matrix. System matrix for thick and thin lenses. Cardinal points of optical system. Application to image formation by combination of two lenses. Concept of objective and eyepiece, Huygens Eyepiece and Ramsden Eyepiece as examples of lens combination, merits and demerits.	A. K.Kole	Lecture Based & Experiential Learning		8
3	Seidal aberration and its different types. Its removal, Abbes Sine condition. Aplanatism and Aplanatic Surface. Its application to high power microscope objective. Chromatic aberration – longitudinal and transverse. Achromatism- achromatic doublet and separated doublet.	A. K.Kole	Lecture Based & Experiential Learning		4
4	Plane Progressive elastic waves, Spherical and Cylindrical Waves; Longitudinal and Transverse Waves, Differential Equation for progressive wave (1d and 3d) and harmonic solutions, Relations	A. K.Kole	Lecture Based & Experiential Learning		8

	among dilatation, condensation and excess pressure, Derivations of wave velocity of a longitudinal wave through an elastic medium and transverse wave through a string, Phase and Group velocity, Energy Transport associated with a Longitudinal Wave, Intensity of Wave. Definition and properties of wave front, Huygens Principle				
5	Definition and properties of wave front, Huygens Principle, Young's experiment; spatial and temporal coherence; intensity distribution; Fresnel's biprism, interference in thin film; fringes of equal inclination and equal thickness; Newton's ring. Michelson's interferometer, Multiple beam interference – reflected and transmitted pattern. Fabry-Perot interferometer	A. K.Kole	Lecture Based & Experiential Learning		7
6	Fresnel and Fraunhofer class, Fresnel's half period zones; explanation of rectilinear propagation of light; zone plate. Fraunhofer diffraction due to a single slit, double slit and circular aperture (qualitative). Plane diffraction grating (transmission). Rayleigh criterion of resolution; resolving power of prism, telescope, microscope and transmission grating.	A. K.Kole	Lecture Based & Experiential Learning		7
7	Different states of polarisation; double refraction, Malus law, Huygen's construction for uniaxial crystals; polaroids and their uses. Lissajous Figures: Production and analysis of plane, circularly and elliptically polarised light by retardation plates and Babinet compensator; Rotatory polarisation and optical activity; Fresnel's explanation of optical activity; Biquartz and half shade polarimeter	A. K.Kole	Lecture Based & Experiential Learning		7

References/ Suggested Readings:

1. Waves: Berkeley Physics Course, vol. 3, Francis Crawford, 2007, Tata McGraw-Hill.
2. Fundamentals of Optics, F.A. Jenkins and H.E. White, 1981, McGraw-Hill
3. Principles of Optics, Max Born and Emil Wolf, 7th Edn., 1999, Pergamon Press.

4. Optics, Ajoy Ghatak, 2008, Tata McGraw Hill
5. The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons.
6. Fundamental of optics, F. A. Jenkins & H. E. White, 1981, Tata McGraw hill.
7. Introduction To Optics- A.K. Ghatak
8. Optics- Hetch And Zajack.
9. A Textbook On Optics- B. Ghosh And K.G. Mazumdar.

WEB REFERENCES:
1. MIT Open Learning - Massachusetts Institute of Technology,
https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning (NPTEL),
https://www.youtube.com/user/nptelhrd

SEMESTER: III
Course Name: Fundamentals of Optics
Course type: **MINOR**
Course code: **BSCPHYMN301**
Course details: MNC-3
Course Type: MNC-3
Course Details: Fundamentals of Optics
L-T-P: 3-0-4
Course Objective:-
This course reviews the concepts of waves and optics learnt at school from a more advanced perspective and goes on to build new concepts. It begins with explaining ideas of lens and different types of optical devices. The course also provides an in depth understanding of wave phenomena of light, namely, interference, diffraction and polarization with emphasis on practical applications of the same.
Course Learning Outcomes:
On successfully completing the requirements of this course, the students will have the skill and knowledge to:
• Understand Interference as superposition of waves from coherent sources derived from same parent source.

• Demonstrate basic concepts of Diffraction: Superposition of wavelets diffracted from aperture, understand Fraunhoffer and Fresnel Diffraction.
• In the laboratory course, student will gain hands-on experience of using various optical instruments.

Unit No.	Topic/Subtopic	Name of the Teacher	Method and Means of Teaching	Suggested Books/Journals/E-Content	No. of Hours Allotted to the Topic/ Subtopic in the entire Teaching Phase of 90 days in a Semester*
1	Concept of ray, ray optics limit, geometrical and optical path, Fermat's Principle, Principle of least path and extremum paths- example of extremum path. Aplanatic surface, Application to laws of reflection and refraction for a) plane surface and b) spherical surface. Application to determine lens formula	A. Dawn	Lecture Based & Experiential Learning	Mentioned later	5
2	Plane Progressive elastic waves, Longitudinal and Transverse Waves, Differential Equation for 1d progressive wave and its solutions, Relations among dilatation, condensation and excess pressure, Derivations of wave velocity of a longitudinal wave through an elastic medium and transverse wave through a string, Phase and Group velocity, Energy Transport associated with a Longitudinal Wave, Intensity of Wave.	A. Dawn			8
3	Electromagnetic nature of light. Definition and Properties of wave front. Huygens Principle. Young's experiment; spatial and temporal coherence; intensity	A. Dawn			10

	distribution; Fresnel's biprism, interference in thin film; fringes of equal inclination and equal thickness; Newton's ring.				
4	Fresnel and Fraunhofer diffraction, Fraunhofer diffraction due to a single slit, double slit. Plane diffraction grating (transmission). Rayleigh criterion of resolution; resolving power of prism.	S. Sarkar			8
5	Transverse nature of light waves. Different states of polarization; double refraction, retardation plates, Malus law, polaroids and their uses. polarizer and analyzer, Production and analysis of plane, circularly and elliptically polarized light, Rotatory polarisation and optical activity; Fresnel's explanation of optical activity; Biquartz and half shade polarimeter	S. Sarkar			7
6	Spontaneous and stimulated emissions, Population inversion, theory of lasing action (Laser). Basic principle of LED , Characteristics and applications . Basic principle of optical fiber, Characteristics and applications. Numerical aperture.	S. Sarkar			7

References/ Suggested Readings:

1. *Fundamentals of Optics, F A Jenkins and H E White, 1976, McGraw-Hill* •
2. Principles of Optics, B.K. Mathur, 1995, Gopal Printing 16 •
3. Fundamentals of Optics, H.R. Gulati and D.R. Khanna, 1991, R. Chand Publication
4. UniversityPhysics.FWSears,MWZemanskyandHDYoung13/e, 1986.AddisonWesley

WEB REFERENCES:

1. MIT Open Learning - Massachusetts Institute of Technology,
https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning (NPTEL),
https://www.youtube.com/user/nptelhrd

SEMESTER- V
Course Name: Quantum Mechanics (Core 11)
Course Code:BSCHPHSC501
(Theory+Lab) [Credits: 06]
Theory - 45 Lectures [Marks : 50]
Course Type: Core (Theory & Practical)
Course Details: CC-11
L-T-P: 4-0-4

Course Learning Outcomes: After the completion of course, the students will have ability to: 1. Explain the failures of classical theory in explaining different experiments of early twentieth century are discussed. 2. Understand ideas of wave-particle duality, matter-wave. 3. Explain how the importance of Schrodinger equation (time-dependent and time-independent) to demonstrate solutions of some systems for different proto-type potentials (1d and 3d) . 4. Understand the concepts of quantum (hermitian) operators and basis vectors.

Unit No.	Topic/Subtopic	Name of the Teacher	Method and Means of Teaching	Suggested Books/Journals/E-Content	No. of Hours Allotted to the Topic/ Subtopic in the entire Teaching Phase of 90 days in a Semester*
1	Planck's formula of black-body radiation	D. Banerjee	Lecture & Experiential Learning	Mentioned later	2

1	Photoelectric effect	D. Banerjee			1
1	Bohr atom and quantization of energy levels	D. Banerjee			2
2	de Broglie hypothesis, Electron double-slit experiment	D. Banerjee			1
2	Compton effect	D. Banerjee			2
2	Davisson-Germer experiment	D. Banerjee			1
2	Heisenberg‟s uncertainty principle (statement) with illustrations	D. Banerjee			1
2	Concept of wave function as describing the dynamical state of a single particle	D. Banerjee			1
2	Group and phase velocities, classical velocity of a particle and the group velocity of the wave representing the particle Principle of superposition	D. Banerjee			1
2	Schrodinger equation. Probabilistic interpretation;	D. Banerjee			1
2	Equation of continuity, probability current density.	D. Banerjee			1
2	Boundary conditions on the wave function.	D. Banerjee			1
3	Dynamical variables as linear hermitian operators and eigenvalue equations	A.K.Kole			2
3	Momentum, energy and angular momentum operators	A.K.Kole			1
3	Measurement of observables, expectation values	A.K.Kole			1
3	Commutation relations between operators	A.K.Kole			2
3	Compatible observables and simultaneous measurements	A.K.Kole			2
3	Ehrenfest theorem	A.K.Kole			2
4	Eigenstates	A.K.Kole			2
4	normalization and orthonormality	A.K.Kole			2
5	One dimensional potential well and barrier, boundary conditions, bound and unbound states	A.K.Kole			2
5	Reflection and transmission coefficients for a rectangular barrier in one dimension – explanation of alpha decay	A.K.Kole			2
5	Free particle in one dimensional box, box normalization, momentum eigenfunctions of a free particle	A.K.Kole			3
5	Linear harmonic oscillator, energy eigenvalues from Hermite differential equation	A.K.Kole			2

5	Wave function for ground state, parity of wave function	A.K.Kole			2
6	Angular momentum operators and their commutation relations	A.K.Kole			2
	Eigenvalues and eigenfunctions of L2 and Lz	A.K.Kole			1
6	Theorem of addition of angular momenta [statement with examples]				1
6	The hydrogen atom problem – stationary state wavefunctions as simultaneous eigenfunctions of H, L2, and Lz				2
6	Radial Schrodinger equation and energy eigenvalues [Laguerre polynomial solutions to be assumed]				2
6	Degeneracy of the energy eigenvalues.				2

References/ Suggested Readings:

1. Introduction to Quantum Mechanics (2nd Edition) by David J. Griffiths
2. Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles, 2ed by Robert Eisberg, Robert Resnick
3. A Textbook Of Quantum Mechanics 2/E by P M Mathews and K Venkatesan
4. Quantum Mechanics: Theory and Applications by Ajoy Ghatak and S. Lokanathan
5. Introductory Quantum Mechanics by S. N. Ghoshal
6. Modern Physics by A. Beiser

SEMESTER-V
Course Name: Thermal Physics II
Course Code: BSCHPHSSC502
Course Type: Core(Theory)
Course Details:CC-12
L-T-P: 5-1-0

Course Learning Outcomes: *After the completion of course, the students will have ability to:*
1. *Demonstrate a mastery of the core knowledge in the areas of Thermal Physics.*

2. *Explain the concept of thermodynamic as an emperical description for the thermal properties of a macroscopic system.*
3. *Understand the applications of thermodynamics and the theory of the phase-transitions are discussed.*

Unit No.	Topic/Subtopic	Name of the Teacher	Method and Means of Teaching	Suggested Books/Journals/E-Content	No. of Hours Allotted to the Topic/ Subtopic in the entire Teaching Phase of 90 days in a Semester*
1	Basic concepts: microscopic and macroscopic points of view; exact and inexact differentials		Lecture	Mentioned later	1
1	Thermodynamic variables of a system;; thermal equilibrium and the zeroth law				1
1	Concept of temperature: internal energy; external work; thermodynamic equilibrium quasi –static processes				1
1	First law of thermodynamics and applications magnetic systems;				1
1	Specific heats and their ratio; isothermal and adiabatic changes in perfect and real gases.				2
2	Reversible and irreversible processes;;:				1
2	Carnot‟s cycle and Carnot‟s theorem – efficiency of heat engines				2
2	Entropy; second law of thermodynamics –different formulations and their equivalence				1
2	Clausius theorem: entropy changes in simple processes				2
2	T -S diagrams for simple processes; isothermal and adiabatic elasticities				1
2	Increase of entropy in natural processes; entropy and disorder				2

2	Probabilistic interpretation of entropy. Kelvin‟s scale of temperature – relation to perfect gas scale				1
3	Enthalpy, Helmholtz and Gibbs Free energies				1
3	Legendre transformations				1
3	Maxwell's relations and simple deductions using these				2
3	thermodynamic equilibrium and free energies				1
4	External Combustion engine – steam engine and				1
4	the Rankinecycle				1
4	Internal combustion engines – Otto and				2
4	Diesel cycles				1
5	Compression and absorption types of machines				5
6	Gibbs Helmholtz equation				2
7	Equilibrium between phases and triple point; Clausius Clapeyron‟s equation				1
7	Gibbs phase rule and simple applications;				1
7	First and higher order phase transitions – Ehrenfest's classification				1
7	Joule Thomson effect; inversion temperature, regenerative cooling				1
7	Liquefaction of air, hydrogen and helium				1
7	Cooling by adiabatic expansion and adiabatic demagnetization				1
8	Thermodynamic functions for a mixture of gases				1
8	Change of entropy in diffusion				1
8	Law of mass action; heat of reaction; effect of temperature and pressure on reaction constant				1
8	Chemical potential; conditions of chemical equilibrium principle of Le - Chatelier				1
8	Nernst heat theorem; third law of thermodynamics				1

References/ Suggested Readings:

1. Saha and Srivastava : A Treatise on Heat – Indian Press, Allahabad.

2. Zemansky and Ditman; Heat and Thermodynamics – McGraw Hill Kogakusha.
3. Sears and Salinger : Thermodynamics, Statistical Mechanics and Kinetic Theory – Narosa.
4. Kittel and Kroemer : Thermal Physics – Freeman.
5. Loeb : Kinetic Theory - Radha
6. Jeans : Dynamical theory of Gases - Cambridge
7. Fermi : Thermodynamics – Chicago University Press
8. Callen : Thermodynamics – Wiley International
9. Pratip Chaudhuri :Gaser Anabiktatwa (in Bengali) = W.B. state Book Board.
10. Ashoke Ghosh :Tapgatitatwa (in Bengali) – W.B. state Book Board.
11. Thermal Physics by Roy & Gupta

SEMESTER-V
Discipline Specific Elective (DSE I & II)
Course Name: Nuclear and Particle Physics
Course Code: BSCHPHSDSE501
(Theory) [Credits: 06]
Theory - 60 Lectures [Marks : 50]
Course Type: DSEC(Theory)
Course Details: DSEC1&2
L-T-P: 5-1-0

Course Learning Outcomes:
After the completion of course, the students will have ability to:
1. *Explain structure and properties of nuclei, the mechanism of different radioactive decays and their applications in peaceful use of nuclear energy.*
2. *Understand what are the elementary particles that constitute this known universe.*
3. *Gather capability of elementary problem solving in nuclear and particle physics.*

Unit No.	Topic/Subtopic	Name of the Teacher	Method and Means of Teaching	Suggested Books/Journals/E-Content	No. of Hours Allotted to the Topic/ Subtopic in the entire Teaching Phase of 90 days in a Semester*
1	Constituents of nucleus and their Intrinsic properties	D. Banerjee	Lecture Based Learning	Mentioned later	2
1	Quantitative facts about mass, radii, charge density (matter density)	D. Banerjee			1
1	Binding energy, average binding energy and its variation with mass number	D. Banerjee			2
1	Main features of binding energy versus mass number curve, N/A plot	D. Banerjee			1
1	Angular momentum, parity	D. Banerjee			2
1	Magnetic moment, electric moments, nuclear excites states	D. Banerjee			2
2	Liquid drop model approach	S.Sarkar			2
2	Semi empirical mass formula and significance of its various terms	S.Sarkar			2
2	Condition of nuclear stability, two nucleon separation energies	S.Sarkar			1
2	Fermi gas model (degenerate fermion gas, nuclear symmetry potential in Fermi gas)	S.Sarkar			2
2	Evidence for nuclear shell structure	S.Sarkar			1
2	Nuclear magic numbers, basic assumption of shell model	S.Sarkar			2
2	Concept of mean field, residual interaction	S.Sarkar			1
2	Concept of nuclear force	S.Sarkar			1
3	Alpha decay: basics of α-decay processes, theory of α- emission	A.Dawn			2
3	Gamow factor, Geiger Nuttall law, α-decay spectroscopy	A.Dawn			1

3	(b) β-decay: energy kinematics for β-decay	A.Dawn			1
3	Positron emission, electron capture, neutrino hypothesis, Reines and Cowan experiment	A.Dawn			1
3	(c) Gamma decay: Gamma rays emission & kinematics	A.Dawn			2
3	Gamma ray interaction through matter	A.Dawn			1
3	Internal conversion	A.Dawn			1
3	Photoelectric effect	A.Dawn			1
3	Compton scattering, pair production	A.Dawn			1
3	Neutron interaction with matter	A.Dawn			1
4	Types of Reactions	D. Banerjee			1
4	Conservation Laws, kinematics of reactions	D. Banerjee			1
4	Q-value, reaction rate, reaction cross section	D. Banerjee			2
4	Concept of compound and direct Reaction	D. Banerjee			1
4	Resonance reaction	D. Banerjee			1
4	Coulomb scattering (Rutherford scattering)	D. Banerjee			2
5	Accelerator facility available in India:, Van-de Graaff generator (Tandem accelerator)	S.Sarkar			1
5	Linear accelerator	S.Sarkar			1
5	Cyclotron	S.Sarkar			1
5	Betatron	S.Sarkar			1
5	Synchrotrons	S.Sarkar			1
6	Discovery of elementary particles				2
6	Particle interactions; basic features				2
6	types of particles and its families				2
6	Symmetries and Conservation Laws: energy and momentum, angular momentum, parity, baryon number, Lepton number, Isospin, Strangeness and charm				5
6	concept of quark				2

References/ Suggested Readings:

1. Introductory nuclear Physics by Kenneth S. Krane (Wiley India Pvt. Ltd., 2008).

2. Concepts of nuclear physics by Bernard L. Cohen. (Tata Mcgraw Hill, 1998).
3. Introduction to the physics of nuclei & particles, R.A. Dunlap. (Thomson Asia, 2004).
4. Introduction to High Energy Physics, D.H. Perkins, Cambridge Univ. Press.
5. Introduction to Elementary Particles, D. Griffith, John Wiley & Sons.
6. Quarks and Leptons, F. Halzen and A.D. Martin, Wiley India, New Delhi.
7. Basic ideas and concepts in Nuclear Physics - An Introductory Approach by K. Heyde (IOP- Institute of Physics Publishing, 2004).
8. Radiation detection and measurement, G.F. Knoll (John Wiley & Sons, 2000).
9. Physics and Engineering of Radiation Detection, Syed Naeem Ahmed (Academic Press, Elsevier, 2007).
10. Theoretical Nuclear Physics, J.M. Blatt & V. F. Weisskopf (Dover Pub.Inc., 1991).
11. Nuclear Physics by D C Tayal
12. Nuclear Physics by S B Pattel

SEMESTER-V
Discipline Specific Elective (DSE I & II)
Course Name: Atomic Physics & Spectroscopy
Course Code: BSCHPHSDSE503
(Theory) [Credits: 06]
Theory - 60 Lectures [Marks : 50]
Course Type: DSEC (Theory)
Course Details: DSEC1&2
L-T-P: 5-1-0

Course Learning Outcomes:
After the completion of course, the students will have ability to:
1. *Understand the concepts of atomic spectra and its origin using the old quantum theory whose consistency can be later verified by the direct application of the quantum mechanics.*
2. *Account for theoretical models, terminology & working methods used in atomic and molecular physics.*
3. *Carry out experimental and theoretical studies on atomic and molecular physics with focus on structure and dynamics of atoms and molecules.*

Unit No.	Topic/Subtopic	Name of the Teacher	Method and Means of Teaching	Suggested Books/Journals/E-Content	No. of Hours Allotted to the Topic/ Subtopic in the entire Teaching Phase of 90 days in a Semester*
1	Good quantum numbers, and selection rules...	S. Sarkar	Lecture Based Learning	Mentioned later	2
1	Stern-Gerlach experiment and spin as an intrinsic quantum number	S. Sarkar			3
1	Incompatibility of spin with classical ideas	S. Sarkar			1
1	Bohr-Sommerfeld model.	S. Sarkar			3
1	Fine structure.	S. Sarkar			2
1	Study of fine structure by Michelson interferometer	S. Sarkar			3
2	Magnetic moment of the electron,...	D.Banerjee			2
2	Lande g factor	D.Banerjee			2
2	Vector model – space quantization	D.Banerjee			4
2	Zeeman effect	D.Banerjee			3
2	Explanation from vector atom model	D.Banerjee			3
3	Pauli exclusion principle	A.Dawn			2
3	Shell structure	A.Dawn			3
3	Hund‟s rule	A.Dawn			2
3	spectroscopic terms of many electron atoms in the ground state.	A.Dawn			3
4	Diatomic molecules – rotational and vibrational energy levels.	S. Sarkar			3
4	Basic ideas about molecular spectra.	A.Dawn			3

4	Raman effect and its application to molecular spectroscopy (qualitative discussion only).	A.Dawn			6
5	Population inversion	D.Banerjee			2
5	Einstein's A and B coefficients	D.Banerjee			2
5	Feedback of energy on a resonator	D.Banerjee			2
5	3-level and 4- level systems	D.Banerjee			2
5	Ruby Laser and He-Ne Laser	D.Banerjee			2

References/ Suggested Readings:

1. Atomic Physics (Modern Physics) by Ghoshal S. N.
2. Concepts of Modern Physics by Arthur Beiser and Shobhit Mahajan.
3. Introduction to Atomic Spectra by Harvey Elliott White
4. Atomic & Molecular Spectra: Laser" by Raj Kumar
5. Elements of Spectroscopy Atomic, Molecular and Laser Physics" by Gupta
6. Modern Atomic Physics by Vasant Natarajan
7. Quantum Mechanics by S N Ghosal
8. Modern Physics by Mani & Mehta