B.Sc. (Hons.) Physics

Course Structure and Syllabus

(Based on Choice Based Credit System)

2021 onwards

University Main Campus
and
Constituent Campuses

Department of Academics

I.K. Gujral Punjab Technical University

PROGRAM EDUCATIONAL OBJECTIVES: At the end of the program, the student will be able to:

PEO1	Apply principles of basic science concepts in understanding, analysis, and prediction of physical systems.
PEO2	Develop human resource with knowledge, abilities and insight in Physics and related fields required for career in academia and industry.
PEO3	Engage in lifelong learning and adapt to changing professional and societal needs.

PROGRAM OUTCOMES: At the end of the program, the student will be able to:

PO1	Apply the knowledge gained to solve the scientific problems.
PO2	Identify, formulate, and analyze scientific problems reaching substantiated conclusions using first principles of mathematical, physical, and chemical sciences.
PO3	Design solutions for physics problems that meet the specified needs with appropriate attention to health and safety risks, applicable standards, and economic, environmental, cultural and societal consideration.
PO4	Use research-based knowledge and methods including design of experiments, analysis, interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	Create, select, and apply appropriate techniques, resources, and modern scientific tools to physics problems with an understanding of the limitations.
PO6	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues, and the consequent responsibilities relevant to the professional scientific practice.
PO7	Understand the impact of the scientific solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	Apply ethical principles and commit to the norms of scientific practice.
PO9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	Communicate effectively on scientific activities with the Scientific/Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	Demonstrate knowledge and understanding of the scientific principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of scientific and technological change.

PROGRAM SPECIFIC OUTCOMES: At the end of the program, the student will be able to:

PSO1	Understand the concepts of different branches of physics.
PSO2	Demonstrate expertise to conduct wide range of scientific experiments.
PSO3	Apply the concepts of physics in areas of mechanics, electromagnetism, solid state, nuclear, etc., in industry, academia, and day-to-day life.

First Semester

Course type	Course Code	Course Title	Load Allocation			Marks Distribution		Total Marks	Cr
			L	T	P	Internal	External		
PHYSICS-C-1	BSHP-111-21	Optics	3	1	-	40	60	100	4
PHYSICS-C-2	BSHP-112-21	Mechanics	3	1	-	40	60	100	4
PHYSICS-C	BSHP-113-21	Physics Lab-I	-	-	4	30	20	50	2
GE-1	BSHM-104-21	Calculus	4	1	-	40	60	100	4
GE-2	BHCL-103-21	Inorganic Chemistry	3	1	-	40	60	100	4
	BHCP-109-21	Chemistry Lab-I	-	-	4	30	20	50	2
AEC-1	BHHL-105-21	Communicative English-I	2	-	-	20	30	50	2
AEC-2	BHHL-106A-21 or BHHL-106B-21	Punjabi Compulsory-I Mudhli Punjabi-I	2	-	-	20	30	50	2
		TOTAL	**17**	**4**	**8**	**260**	**340**	**600**	**24**

PHYSICS-C: PHYSICS-Core General Elective: GE Ability Enhancement Compulsory: AEC
L: Lecture T: Tutorial P: Practical Cr: Credit

Second Semester

Course type	Course Code	Course Title	Load Allocation			Marks Distribution		Total Marks	Cr
			L	T	P	Internal	External		
PHYSICS-C-3	BSHP-121-21	Waves and Vibrations	3	1	-	40	60	100	4
PHYSICS-C-4	BSHP-122-21	Electricity and Magnetism	3	1	-	40	60	100	4
PHYSICS-C	BSHP-123-21	Physics Lab-II	-	-	4	30	20	50	2
GE-3	BSHM-204-21	Vector Algebra & Vector Analysis	4	1	-	40	60	100	4
GE-4	BHCL-114-21	Organic Chemistry	3	1	-	40	60	100	4
	BHCP-116-21	Chemistry Lab-II	-	-	4	30	20	50	2
AEC-3	BHHL-115-21	Communicative English-II	2	-	-	20	30	50	2
AEC-4	BHHL-116A-21 or BHHL-116A-21	Punjabi Compulsory-II Mudhli Punjabi-II	2	-	-	20	30	50	2
		TOTAL	**17**	**4**	**8**	**260**	**340**	**600**	**24**

Third Semester

Course type	Course Code	Course Title	Load Allocation			Marks Distribution		Total Marks	Cr
			L	T	P	Internal	External		
PHYSICS-C-5	BSHP-211-21	Mathematical Physics-I	5	1	-	40	60	100	6
PHYSICS-C-6	BSHP-212-21	Elements of Modern Physics	3	1	-	40	60	100	4
	BSHP-213-21	Physics Lab-III	-	-	4	30	20	50	2
PHYSICS-C-7	BSHP-214-21	Analog Systems and Application	3	1	-	40	60	100	4
	BSHP-215-21	Physics Lab-IV	-	-	4	30	20	50	2
GE-5	BHCL-204-21	Physical Chemistry	3	1	-	40	60	100	4
	BHCP-208-21	Chemistry Lab-III	-	-	4	30	20	50	2
PHYSICS-SEC-1	BSHP-216-21	Workshop Skill Enhancement	-	1	2	30	20	50	2
	BSHP-217-21	Computational Physics							
	BSHP-218-21	Weather Forecasting							
	TOTAL		**14**	**5**	**14**	**280**	**320**	**600**	**26**

PHYSICS-SEC: PHYSICS-Skill Enhancement Elective Course

Fourth Semester

Course type	Course Code	Course Title	Load Allocation			Marks Distribution		Total Marks	Cr
			L	T	P	Internal	External		
PHYSICS-C-8	BSHP-221-21	Mathematical Physics-II	5	1	-	40	60	100	6
PHYSICS-C-9	BSHP-221-21	Thermal Physics	3	1	-	40	60	100	4
	BSHP-223-21	Physics Lab-V	-	-	4	30	20	50	2
PHYSICS-C-10	BSHP-224-21	Digital Electronics	3	1	-	40	60	100	4
	BSHP-225-21	Physics Lab-VI	-	-	4	30	20	50	2
GE-6	BSHM-408-21	Matrices & Ordinary Differential Equations	4	1	-	40	60	100	4
AEC-5	EVS-101A	Environmental Studies	2	-	-	20	30	50	2
PHYSICS-SEC-2	BSHP-226-21	Electrical Circuits and Network Skills	-	1	2	30	20	50	2
	BSHP-227-21	Basic Instrumentation Skills							
	BSHP-228-21	Scientific Word Processing							
	TOTAL		**17**	**5**	**10**	**270**	**330**	**600**	**26**

Fifth Semester

Course type	Course Code	Course Title	Load Allocation			Marks Distribution		Total Marks	Cr
			L	T	P	Internal	External		
PHYSICS-C-11	BSHP-311-21	Quantum Mechanics	5	1	-	40	60	100	6
PHYSICS-C-12	BSHP-312-21	Solid State Physics	3	1	-	40	60	100	4
PHYSICS-C	BSHP-313-21	Physics Lab-VII	-	-	4	30	20	50	2
PHYSICS-C	BSHP-314-21	Computational Physics Lab-I	-	-	4	30	20	50	2
DSE-1 DSE-2	BSHP-315-21 BSHP-316-21	Department Specific Elective (DSE)-1	5	1	-	40	60	100	6
DSE-3 DSE-4 DSE-5	BSHP-317-21 BSHP-318-21 BSHP-319-21	Department Specific Elective (DSE)-2	5	1	-	40	60	100	6
	TOTAL		**18**	**4**	**8**	**220**	**280**	**500**	**26**

Department Specific Electives -1 and 2 (Any two from the following list)

S. No.	Name of the Subject	Code
1	Atomic and Molecular Physics	BSHP-315-21
2	Nuclear Physics	BSHP-316-21
3	Dissertation	BSHP-317-21
4	Communication Electronics	BSHP-318-21
5	Renewable Energy and Energy Harvesting	BSHP-319-21

Sixth Semester

Course type	Course Code	Course Title	Load Allocation			Marks Distribution		Total Marks	Cr
			L	T	P	Internal	External		
PHYSICS-C-13	BSHP-321-21	Electromagnetic Theory	5	1	-	40	60	100	6
PHYSICS-C-14	BSHP-322-21	Statistical Mechanics	3	1	-	40	60	100	4
PHYSICS-C	BSHP-323-21	Physics Lab -VIII	-	-	4	30	20	50	2
DSE-6 DSE-7	BSHP-324-21 BSHP-325-21	Department Specific Elective (DSE)-3	5	1	-	40	60	100	6
DSE-8 DSE-9 DSE-10	BSHP-326-21 BSHP-327-21 BSHP-328-21	Department Specific Elective (DSE)-4	5	1	-	40	60	100	6
	TOTAL		**18**	**4**	**4**	**190**	**260**	**450**	**24**

Department Specific Electives- 3 and 4 (Any two from the following list)

S. No.	Name of the Subject	Code
1	Particle Physics	BSHP-324-21
2	Advanced Mathematical Physics	BSHP-325-21
3	Advanced Condensed Matter Physics	BSHP-326-21
4	Experimental Techniques	BSHP-327-21
5	Radiation Safety	BSHP-328-21

Examination and Evaluation

Theory			
S. No.	**Evaluation criteria**	**Weightage in Marks**	**Remarks**
1	Mid term/sessional Tests	24	Internal evaluation (40 Marks) MSTs, Quizzes, assignments, attendance, etc., constitute internal evaluation. Average of two mid semester test will be considered for evaluation.
2	Attendance	6	
3	Assignments	10	
4	End semester examination	60	External evaluation
5	Total	100	Marks may be rounded off to nearest integer.
Practical			
1	Evaluation of practical record/ Viva Voice/Attendance/Seminar/ Presentation	30	Internal evaluation
2	Final Practical Performance + Viva-Voce	20	External evaluation
3	Total	50	Marks may be rounded off to nearest integer.

Instructions for Paper-Setter in B. Sc. (Hons.) Physics

A. Scope

1. The question papers should be prepared strictly in accordance with the prescribed syllabus and pattern of question paper of the University.

2. The question paper should cover the entire syllabus with proper distribution and Weightage of marks for each question.

3. The language of questions should be simple, direct, and documented clearly and unequivocally so that the candidates may have no difficulty in appreciating the scope and purpose of the questions. The length of the expected answer should be specified as far as possible in the question itself.

4. The distribution of marks to each question/answer should be indicated in the question paper properly.

B. Type and difficulty level of question papers

1. Questions should be framed in such a way as to test the students intelligent grasp of broad principles and understanding of the applied aspects of the subject. The Weightage of the marks as per the difficulty level of the question paper shall be as follows:
   - i) Easy question 30%
   - ii) Average questions 50%
   - iii) Difficult questions 20%
2. The numerical content of the question paper should be upto 25%.

C. Format of end semester question paper

1. Paper code and Paper-ID should be mentioned properly.
2. The question paper will consist of three sections: Sections-A, B and C.
3. Section-A is COMPULSORY consisting of TEN SHORT questions carrying two marks each (total 20 marks) covering the entire syllabus.
4. The Section-B consists of FOUR questions of eight marks each covering the entire PART-A of syllabus (Taking two questions from every unit).
5. The Section-C consists of FOUR questions of eight marks each covering the entire PART-B of syllabus (Taking two questions from every unit).
6. Attempt any five questions from Section-B and Section-C, selecting at least two questions from each of the two sections.

Question paper pattern for MST:

Roll No:	**No of pages:**

IK Gujral Punjab Technical University-Jalandhar	
Department of Physical Sciences	
Academic Session:	
Mid-Semester Test: I/II/III (Regular/reappear)	**Date:**
Programme: B.Sc. (Hons.) Physics	**Semester:**
Course Code:	**Course:**
Maximum Marks: 24	**Time: 1 hour 30 minutes**

- Note: Section A is compulsory; Attempt any two questions from Section B and one question from Section C.

Section: A		**Marks**	**COs**
1		2	
2		2	
3		2	
4		2	
Section: B			
5		4	
6		4	
7		4	
Section: C			
8		8	
9		8	

Details of Course Objectives

CO1	
CO2	
CO3	
CO4	
CO5	

SEMESTER-I

PHYSICS-C-1	**BSHP-111-21**	**Optics**	**L-3, T-1, P-0**	**4 Credits**

Pre-requisite: Understanding of senior secondary level Physics and Mathematics

Course Objectives: The objective of the course is to develop basic understanding of Interference, Diffraction and Polarization among students. They also learn about the LASER and its applications. Students will be equipped with knowledge to measure wavelength, refractive index and other related parameters, which will act as a strong background if he/she chooses to pursue physics as a career.

Course Outcomes: At the end of the course, the student will be able to

CO1	Identify and illustrate physical concepts and terminology used in optics and other related wave phenomena
CO2	Analyze and understand coherence and phenomenon of interference and their applications
CO3	Acquainted with Fresnel's and Fraunhofer's diffraction and their applications.
CO4	Get thorough knowledge of the polarization of light, changes upon reflection and transmission and will learn to analyze the polarization in optical systems.
CO5	Describe the different types of lasers, its principle, properties and applications of laser beam.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	1	-	1	2	1	2	3	2	2
CO2	2	2	1	2	1	1	1	1	1	3	1	1
CO3	3	2	2	2	1	1	2	1	1	3	1	1
CO4	2	2	2	2	1	1	2	1	1	3	1	1
CO5	2	2	2	2	1	1	2	1	1	3	1	1

Detailed Syllabus:

PART-A

UNIT I

Interference: Definition and properties of wave front, Temporal and Spatial Coherence, Young's double slit experiment, Lloyd's single mirror and Fresnel's Biprism. Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel and wedge-shaped films, Fringes of equal inclination (Haidinger Fringes), Newton's Rings: Measurement of wavelength and refractive index, Interferometer: Michelson Interferometer-(1) idea of form of fringes (No theory required), (2) Determination of Wavelength, (3) Wavelength Difference, (4) Refractive Index, Fabry-Perot interferometer. (11 Lectures)

UNIT-II

Diffraction: Huygens Principle, Huygens-Fresnel Diffraction theory, Fraunhofer diffraction: Single slit. Circular aperture, Rayleigh criterion of resolution, Resolving Power of a telescope, Double slit, Multiple slits, Diffraction grating, Resolving power of grating. Fresnel Diffraction: Fresnel's Assumptions, Fresnel's Half-Period Zones for Plane Wave. Explanation of Rectilinear Propagation of Light, Theory of a Zone Plate: Multiple Foci of a Zone Plate, Fresnel diffraction pattern of a straight edge and circular aperture. (11 Lectures)

PART-B

UNIT-III

Polarization: Plane polarized light, Representation of Unpolarized and Polarized light, Polarization by Reflection, Brewster's law, Malus Law, Polarization by Selective absorption by Crystals, Polarization by Scattering, Polarization by Double Refraction, Nicol Prism, Huygen's theory of Double Refraction, Polaroid, Elliptically and Circularly polarized lights, Quarter and Half wave plates. (11 Lectures)

UNIT-IV

Laser and Application: Lasers, Spontaneous emission, Stimulated absorption, Stimulated emission, Einstein coefficients, Einstein relations, Conditions for Laser actions, Population inversion, Different types of Laser Pumping mechanism: Optical Pumping, Electric Discharge and Electrical pumping, Resonators, Two, Three and Four level laser systems, Ruby laser, He-Ne gas Laser, Semiconductor laser, CO_2 laser, applications of laser: Holography, Principle of Holography. (11 Lectures)

Text and Reference Books:

1. Optics: A.K. Ghatak (Tata-McGraw Hill), 1992.
2. Fundamentals of Optics: F.A. Jenkins and H.E. White (McGraw Hill), 1981.
3. A Textbook of Optics: Subrahmaniyam N. & et al., S. Chand Publishing, 2006.
4. O. Svelto: Principles of Lasers, Springer Science & Business Media, 2010.

PHYSICS-C-2	**BSHP-112-21**	**Mechanics**	**L-3, T-1, P-0**	**4 Credits**

Pre-requisite: Understanding of senior secondary level Physics and Mathematics

Course Objectives: The aim and objective of the course on Mechanics is to introduce the students to the formal structure of vector mechanics, harmonic oscillators, and mechanics of solids so that they can use these in Engineering as per their requirement. This will act as a strong background if he/she chooses to pursue higher studies in physics.

Course Outcomes: At the end of the course, the student will be able to

CO1	Understand the fundamentals of vector mechanics for a classical system.
CO2	Identify various types of forces in nature, frames of references, and conservation laws.
CO3	Know the inertial and non-inertial system.
CO4	Understand the Gravitation force as a Central Force Motion
CO5	Apply the knowledge obtained in this course to day-to-day problems.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	-	1	2	1	2	1	2	3	2	2
CO2	2	3	1	2	2	1	1	1	1	3	1	1
CO3	3	3	2	2	2	1	2	1	1	3	1	1
CO4	2	2	2	-	2	1	2	1	1	3	1	1
CO5	2	2	-	2	2	1	2	1	1	3	1	1

Detailed Syllabus:

UNIT I:

Fundamentals of Dynamics: Reference frames. Inertial frames; Review of Newton's Laws of Motion. Galilean transformations; Galilean invariance. Dynamics of a system of particles. Centre of Mass. Principle of conservation of momentum. Impulse. Momentum of variable-mass system: motion of rocket. (12 Lectures)

UNIT II:

Work and Energy: Work and Kinetic Energy Theorem. Conservative and non-conservative forces. Potential Energy. Energy diagram. Stable and unstable equilibrium. Force as gradient of potential energy. Work done by non-conservative forces. Law of conservation of Energy.

Collisions: Elastic and inelastic collisions between particles. Centre of Mass and Laboratory frame of references. (12 Lectures)

UNIT-III

Non-Inertial Systems: Non-inertial frames and fictitious forces. Uniformly rotating frame. Laws of Physics in rotating coordinate systems. Centrifugal force. Coriolis force and its applications. Components of Velocity and Acceleration in Cylindrical and Spherical Coordinate Systems. (12 Lectures)

UNIT-IV

Gravitation and Central Force Motion: Law of gravitation. Gravitational potential energy. Inertial and gravitational mass. Potential and fields due to spherical shell and solid sphere. Motion of a particle under a central force field. Two-body problem and its reduction to one-body problem and its solution. The energy equation and energy diagram. Kepler's Laws. Satellite in circular orbit and applications. Geosynchronous orbits. Weightlessness. Basic idea of global positioning system (GPS). (12 Lectures)

Text and Reference Books:

1. Mechanics, Berkeley Physics, Vol.1,C.Kittel, W.Knight, et.al. 2007, Tata McGraw-Hill.
2. Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley.
3. Feynman Lectures, Vol. I, R.P.Feynman, R.B.Leighton, M. Sands, 2008, Pearson Education
4. Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons
5. University Physics. F.W Sears, M.W Zemansky, H.D Young 13/e, 1986, Addison Wesley
6. Physics for scientists and Engineers with Modern Phys., J.W.Jewett, R.A.Serway, 2010, Cengage Learning
7. Theoretical Mechanics, M.R. Spiegel, 2006, Tata McGraw Hill.

PHYSICS-C	**BSHP-113-21**	**Physics Lab-I**	**L-0, T-0, P-4**	**2 Credits**

Pre-requisite (If any): High-school education

Course Objectives: The aim and objective of the lab course is to introduce the students to the formal structure of electromagnetism and phenomenon of wave optics so that they can use these as per their requirement.

Course Outcomes: At the end of the course, the student will be able to

CO1	Able to verify the theoretical concepts/laws learnt in theory courses.
CO2	Trained in carrying out precise measurements and handling sensitive equipment.
CO3	Understand the methods used for estimating and dealing with experimental uncertainties and systematic "errors".
CO4	Learn to draw conclusions from data and develop skills in experimental design.
CO5	Document a technical report which communicates scientific information in a clear and concise manner.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	2	1	2	1	2	3	2	3
CO2	3	3	1	-	2	2	1	1	1	3	2	3
CO3	3	3	2	-	2	1	2	1	1	3	2	3
CO4	3	2	2	2	-	2	2	1	1	3	2	3
CO5	2	2	2	2	-	2	2	1	1	3	2	3

Note: Students are expected to perform about 8-10 experiments from the following list, selecting minimum of 6-7 from the Physical Lab and 2-3 from the Virtual lab.

List of experiments:

1. Use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, (d) Capacitances, and (e) Checking electrical fuses.
2. To study the laser beam characteristics like; wavelength, aperture, spot size, etc. using diffraction grating.
3. To study the diffraction using laser beam and thus to determine the grating element.
4. To study wavelength and laser interference using Michelson's Interferometer.
5. To find the refractive index of a material/glass using spectrometer.
6. To find the refractive index of a liquid using spectrometer.
7. To determine the angle of prism and resolving power of a prism.
8. To study the magnetic field of a circular coil carrying current using a Steward and Gees Tangent Galvanometer.
9. Determine the radius of circular coil using the Circular coil.
10. To study B-H curve using CRO.
11. To find out polarizability of a dielectric substance.
12. To find out the horizontal component of earth's magnetic field (B_h).

Text and Reference Books:

1. A Textbook of Practical Physics, I. Prakash & Ramakrishna, 11th Edn, 2011, Kitab Mahal.
2. Engineering Practical Physics, S. Panigrahi & B. Mallick, 2015, Cengage Learning India Pvt. Ltd.
3. Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University Press.
4. Practical Physics, C L Arora. S. Chand & Company Ltd.
5. http://www.vlab.co.in

General Elective (GE)-1	**BSHM-104-21**	**CALCULUS-I**	**L-4, T-1, P-0**	**4 Credits**

Pre-requisite: Understanding of senior secondary level Mathematics

Course Objectives: The objectives of this course are to make the students understand the following:

1. The fundamental concepts of differential and integral calculus.
2. The geometrical meaning of functions, limits, continuity, derivatives, mean value theorems.
3. Applications of derivatives and integrals.
4. Limit, Continuity, partial derivatives and their applications in finding extreme values.
5. The utility of double and triple integrals in finding area and volume bounded by surfaces.

Course Outcomes: At the end of the course, the student will be able to

CO1	Understand the basic concepts of Differential and Integral Calculus.
CO2	Visualize all concepts geometrically.
CO3	Apply the knowledge of derivatives in finding extreme values of the function and definite integrals to find area under the curve.
CO4	Explain the concept of Limit, Continuity, partial derivatives of functions of severable variables and their applications.
CO5	Utilize the concept of multiple integrals in finding areas and volumes of different geometrical shapes.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	2	2	3	2	3	2	2	2	3
CO2	2	1	1	-	2	2	1	3	2	2	2	3
CO3	2	2	2	-	2	1	2	1	2	3	2	3
CO4	1	2	2	2	-	2	2	2	1	3	2	3
CO5	2	2	2	2	-	2	2	1	1	3	2	3

Detailed Syllabus:

UNIT-I

Functions of single variable, Simple examples of limit, continuity, differentiability, Derivative of elementary functions (t-ratios, logarithmic functions, exponential functions), Higher order derivatives, Statement of Mean value theorems and simple applications, Applications of derivative: increasing decreasing functions, extreme values of functions. **(Ref. 1)**

UNIT-II

Integration as an inverse process of differentiation, Finding integrals by partial fractions, by parts, Statement of fundamental theorem of calculus, Finding definite integrals by method of substitution, Applications of definite integral in finding length of an arc, area under simple curves, area enclosed between two curves. **(Ref. 1)**

UNIT-III

Introduction of Limit, continuity of functions of two variables with simple examples, partial derivatives, Total derivatives, Homogeneous functions, Statement of Euler's theorem, Simple examples of maxima-minima of functions of several variables, Lagrange's method of multipliers.

UNIT-IV

Double integrals, Change of order of integration, Jacobian, Double integral in polar coordinates, Triple integrals, Simple applications in finding area and volumes.

RECOMMENDED BOOKS:

- Mathematics, A Text book for Class XII (Parts I & II), New Delhi: NCERT, 2003. **(Unit I & II)**
- R.K. Jain and S.R.K. Iyengar, Advanced Engineering Mathematics, Narosa Pub., 4th Edition, 2015.
- James Stewart, Calculus, 5th Edition, Brooks/Cole (Thomson), 2003.

General Elective (GE)-2	**BHCL-103-21**	**INORGANIC CHEMISTRY**	**L-3, T-1, P-0**	**4 Credits**

Pre-requisite: Understanding of senior secondary level Physics and Mathematics

Course Objectives: To teach the fundamental concepts of Inorganic chemistry and their applications.

Course Outcomes: At the end of the course, the student will be able to

CO1	Understand the fundamental concepts and postulates of various theories regarding the structure of atom.
CO2	Learn the periodicity of the s & p block elements
CO3	Understand the various types of bonding present in the different inorganic compounds
CO4	Learn about the various theories pertaining to the different types of boding
CO5	

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2	2	2	1	2	2	2	3	2	3
CO2	2	3	1	-	2	2	1	2	2	3	2	3
CO3	2	3	2	-	2	1	2	1	2	3	2	3
CO4	3	2	2	2	-	2	2	1	2	3	2	3
CO5	2	2	2	2	-	2	2	1	1	3	2	3

Detailed Syllabus:

PART-A

UNIT-I

Atomic Structure:

Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Wave mechanics: deBroglie equation, Heisenberg's Uncertainty Principle and its significance, Schrödinger's wave equation, significance of ψ and ψ^2. Quantum numbers and their significance. Normalized and orthogonal wave functions. Sign of wave functions. Radial and angular wave functions for hydrogen atom. Radial and angular distribution curves. Shapes of *s*, *p*, *d* and *f* orbitals. Contour boundary and probability diagrams. Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations, Variation of orbital energy with atomic number

UNIT-II

Chemical Bonding-I: Ionic bond: General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals. Born-Landé equation with derivation and importance of Kapustinskii expression for lattice energy. Madelung constant, Born-Haber cycle and its application, Solvation energy.

Metallic Bond: Qualitative idea of valence bond and band theories. Semiconductors and insulators, defects in solids.

Weak Chemical Forces: van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interactions, Instantaneous dipole-induced dipole interactions. Repulsive forces, Hydrogen bonding (theories of hydrogen bonding, valence bond treatment) Effects of chemical force, melting and boiling points, solubility energetics of dissolution process.

UNIT-III

Chemical Bonding-II: Covalent bond: Lewis structure, Valence Bond theory (Heitler-London approach). Energetics of hybridization, equivalent and non-equivalent hybrid orbitals. Bent's rule, Resonance and resonance energy, Molecular orbital theory. Molecular orbital diagrams of diatomic and simple polyatomic molecules N_2, O_2, C_2, B_2, F_2, CO, NO, and their ions; HCl, BeF_2, CO_2, (idea of s-p mixing and orbital interaction to be given). Formal charge, Valence shell electron pair repulsion theory (VSEPR), shapes of simple molecules and ions containing lone pairs and bond pairs of electrons, multiple bonding (σ and π bond approach) and bond lengths. Covalent character in ionic compounds, polarizing power and polarizability. Fajan's rules and consequences of polarization. Ionic character in covalent compounds: Bond moment and dipole moment. Percentage ionic character from dipole moment and electronegativity difference.

UNIT-IV

Chemistry of s and p Block Elements:

Inert pair effect, Relative stability of different oxidation states, diagonal relationship and anomalous behaviour of first member of each group. Allotropy and catenation. Complex formation tendency of s and p block elements. Hydrides and their classification ionic, covalent and interstitial. Basic beryllium acetate and nitrate. Study of the following compounds with emphasis on structure, bonding, preparation, properties and uses. Boric acid and borates, boron nitrides, borohydrides (diborane) carboranes and graphitic compounds, silanes, Oxides and oxoacids of nitrogen, Phosphorus and chlorine. Peroxo acids of sulphur, interhalogen compounds, polyhalide ions, pseudohalogens and basic properties of halogens.

Reference Books :-

1. Lee, J.D. *Concise Inorganic Chemistry*, ELBS, 1991.
2. Douglas, B.E; Mc Daniel, D.H. & Alexander, J.J. *Concepts & Models of Inorganic Chemistry 3rd Ed.*, John Wiley Sons, N.Y. 1994.
3. Greenwood, N.N. & Earnshaw. *Chemistry of the Elements*, Butterworth-Heinemann. 1997.
4. Cotton, F.A. & Wilkinson, G. *Advanced Inorganic Chemistry*, Wiley, VCH, 1999.
5. Miessler, G. L. & Donald, A. Tarr. *Inorganic Chemistry 4th Ed.,* Pearson, 2010.
6. Shriver & Atkins, *Inorganic Chemistry 5th Ed.*

General Elective (GE)-2	**BHCP-109-21**	**CHEMISTRY LAB-I**	**L-0, T-0, P-4**	**2 Credits**

Pre-requisite: Understanding of senior secondary level Chemistry

Course Objectives: The objective of this course is to provide practical knowledge and illustrative experiments about various types of inorganic titrations and preparation of simple inorganic compounds.

Course Outcomes: At the end of the course, the student will be able to

CO1	Understand to calibrate and run the instruments for analysis.
CO2	Learn to the quantitative analysis of various metal ions/cations and anions.
CO3	Understand the various principles of different techniques involved in the quantitative analysis.
CO4	Learn to prepare various inorganic compounds

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2	2	2	1	2	1	2	3	2	3
CO2	2	3	1	3	2	2	1	1		2	2	3
CO3	2	3	2	3	2	1	2	1	1	2	2	3
CO4	2	2	2	2	1	2	2	1	1	3	2	3

List of Experiments:

(A) Titrimetric Analysis
(i) Calibration and use of apparatus
(ii) Preparation of solutions of different Molarity/Normality of titrants
(B) Acid-Base Titrations
(i) Estimation of carbonate and hydroxide present together in mixture.
(ii) Estimation of carbonate and bicarbonate present together in a mixture.
(iii) Estimation of free alkali present in different soaps/detergents
(C) Oxidation-Reduction Titrimetry
(i) Estimation of Fe(II) and oxalic acid using standardized KMnO4 solution.
(ii) Estimation of oxalic acid and sodium oxalate in a given mixture.
(iii) Estimation of Fe(II) with $K_2Cr_2O_7$ using internal (diphenylamine, anthranilic acid) and external indicator.

Reference text:
1. Vogel, A.I. *A Textbook of Quantitative Inorganic Analysis*, ELBS.

Ability Enhancement Compulsory (AEC)-1	**BHHL-105-21**	**Communicative English -I**	**L-2, T-0, P-0**	**2 Credits**

Pre-requisite: Basic proficiency in Communication Skills

Course Objectives: The main objective of this course is:

- To help the students become proficient in LSRW-Listening, Speaking, Reading & Writing skills
- To help the students become the independent users of English language
- To develop in them vital communication skills, integral to their personal, social and professional interactions
- To teach them the appropriate language of professional communication
- To prepare them for job market

Course Outcomes: At the end of the course, the student will

CO1	acquire basic proficiency in reading &listening, writing and speaking skills
CO2	be able to understand spoken and written English language, particularly the language of their chosen technical field.
CO3	be able to converse fluently.
CO4	be able to produce on their own clear and coherent texts.
CO1	become proficient in professional communication, such as, interviews, group discussions, office environments, important reading skills as well as writing skills and thereby will have better job prospects.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	2	2	2	2	3	2	3	2	2
CO2	2	2	2	1	1	2	2	3	2	3	2	2
CO3	1	-	2	1	2	2	2	3	2	3	2	2
CO4	1	-	-	1	1	2	2	3	2	3	2	2
CO5	2	-	-	1	1	2	2	3	2	3	2	2

Detailed Syllabus:

Part –A

UNIT I-(Literature)

(A) ***The Poetic Palette*** **(Orient Black Swan, Second Edition, 2016)**

The following poems from this anthology are prescribed:

1. Pippa's Song: Robert Browning
2. Apparently With No Surprise: Emily Dickinson
3. Fool and Flea: Jeet Thayil

(B) ***Prose Parables*** **(Orient Black Swan, 2013)**

The following stories from the above volume are prescribed:

a. The Kabuliwallah: Rabindranath Tagore
b. The Eyes Are Not Here: Ruskin Bond
c. Grief: Anton Chekov

UNIT-II

Vocabulary: Word Formation Processes; Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives; Synonyms, antonyms

Grammar: Subject-verb agreement; Noun-pronoun agreement; Misplaced modifiers; Articles Determiners; Modals; Prepositions;

PART-B

UNIT-III

Reading and Understanding: Close Reading; Comprehension;

UNIT-IV

Mechanics of Writing & Speaking Skills

Essay Writing (Descriptive/Narrative/Argumentative); Business letters; Précis Writing; Self Introductions; Group Discussion

TEXT AND REFERENCE BOOK

1. John Eastwood, Oxford Practice Grammar, Oxford University Press, 2014
2. Michael Swan, Practical English Usage, OUP. 1995.
3. F.T. Wood, Remedial English Grammar, Macmillan. 2007.
4. William Zinsser, On Writing Well, Harper Resource Book 2001.
5. Sanjay Kumar and Pushp Lata, Oxford University Press. 2011.
6. Communication Skills, Oxford University Press. 2011.
7. Liz Hamp-Lyons and Ben Heasly, Study Writing, Cambridge University Press. 2006.

Ability Enhancement Compulsory (AEC)-2	**BHHL-106A-21**	**ਪੰਜਾਬੀ ਲਾਜ਼ਮੀ (Punjabi Compulsory) -I**	**L-2, T-0, P-0**	**2 Credits**

Pre-requisite: Understanding of senior secondary level Punjabi

Course Objectives: The objective of the course is:
1.To enhance the language ability of students.
2.To enhance the ability of Learning science and developing science literacy through local language teaching with science subjects.

Course Outcomes: At the end of the course, the student will be able to

CO1	Translate and transfer/broadcast the western scientific knowledge in the local language.
CO2	Translate and transfer the indigenous/traditional scientific knowledge available in local knowledge into English and other global languages.
CO3	Understand the society through Punjabi language, literature and culture
CO4	Learning science and in developing science literacy.
CO5	Improve the internal communication.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	2	2	2	2	3	2	3	2	2
CO2	2	2	2	1	1	2	2	3	2	2	2	2
CO3	3	1	2	1	2	2	2	3	2	2	2	2
CO4	3	1	-	1	1	2	2	3	2	3	2	2
CO5	3	1	-	1	1	2	2	3	2	3	2	2

Detailed Syllabus:

PART-A

UNIT I : ਕਵਿਤਾ ਭਾਗ:

ਭਾਈ ਵੀਰ ਸਿੰਘ:

ਸਮਾਂ, ਚਸ਼ਮਾ

ਪ੍ਰੋ. ਪੂਰਨ ਸਿੰਘ :

ਪੰਜਾਬ ਨੂੰ ਕੂਕਾਂ ਮੈਂ, ਹੱਲ ਵਾਹੁਣ ਵਾਲੇ

ਪ੍ਰੋ.ਮੋਹਨ ਸਿੰਘ :

ਮਾਂ, ਕੋਈ ਆਇਆ ਸਾਡੇ ਵਿਹੜੇ, ਪਿਆਰ ਪੰਧ

ਅੰਮ੍ਰਿਤਾ ਪ੍ਰੀਤਮ:

ਆਖਾਂ ਵਾਰਿਸ ਸ਼ਾਹ ਨੂੰ, ਅੰਨਦਾਤਾ *(Lecture 11)*

UNIT-II ਕਹਾਣੀ ਭਾਗ:

ਸੰਤ ਸਿੰਘ ਸੇਖੋਂ :
ਪੇਮੀ ਦੇ ਨਿਆਣੇ
ਸੁਜਾਨ ਸਿੰਘ :
ਕੁਲਫੀ
ਕੁਲਵੰਤ ਸਿੰਘ ਵਿਰਕ :
ਤੂੜੀ ਦੀ ਪੰਡ
ਗੁਰਦਿਆਲ ਸਿੰਘ :
ਸਾਂਝ *(Lecture 12)*

PART-B

UNIT-III

ਭਾਸ਼ਾ ਦਾ ਟਕਸਾਲੀ ਰੂਪ, ਭਾਸ਼ਾ ਤੇ ਉਪ-ਭਾਸ਼ਾ ਵਿਚ ਅੰਤਰ, ਪੰਜਾਬੀ ਦੀਆਂ ਉਪ-ਭਾਸ਼ਾਵਾਂ,ਪੰਜਾਬੀ ਭਾਸ਼ਾ:ਨਿਕਾਸ ਤੇ ਵਿਕਾਸ। ਭਾਸ਼ਾ ਤੇ ਲਿਪੀ, ਗੁਰਮੁਖੀ ਲਿਪੀ ਦੀਆਂ ਵਿਸ਼ੇਸ਼ਤਾਵਾਂ, ਗੁਰਮੁਖੀ ਲਿਪੀ: ਨਿਕਾਸ ਤੇ ਵਿਕਾਸ।

(Lecture 11)

UNIT-IV

ਸੰਖੇਪ ਰਚਨਾ (ਪ੍ਰੈਸੀ)
ਪੈਰ੍ਹਾ ਰਚਨਾ
ਸਰਲ ਅੰਗਰੇਜ਼ੀ ਪੈਰ੍ਹੇ ਦਾ ਪੰਜਾਬੀ ਅਨੁਵਾਦ *(Lecture 11)*

TEXT AND REFERENCE BOOK:

1. ਸੰਪ.ਡਾ.ਮਹਿਲ ਸਿੰਘ, ਸਾਹਿਤ ਦੇ ਰੰਗ, ਰਵੀ ਸਾਹਿਤ ਪ੍ਰਕਾਸ਼ਨ, ਅੰਮ੍ਰਿਤਸਰ, 2016.

Ability Enhancement Compulsory (AEC)-2	**BHHL-106B-21**	ਮੁਢਲੀ ਪੰਜਾਬੀ **(Mudhli Punjabi)-I**	**L-2, T-0, P-0**	**2 Credits**

Pre-requisite: Understanding of senior secondary level Physics and Mathematics

Course Objectives: The objective of the course is to:
1. enhance the language ability of students.
2. enhance the ability of Learning science and developing science literacy through local language teaching with science subjects.

Course Outcomes: At the end of the course, the student will be able to

CO1	Translate and transfer/broadcast the western scientific knowledge in the local language.
CO2	Translate and transfer the indigenous/traditional scientific knowledge available in local knowledge into English and other global languages.
CO3	Understand the society through Punjabi language, literature and culture.
CO4	Learning science and in developing science literacy.
CO5	Improve the internal communication.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	2	2	2	2	3	2	3	2	2
CO2	2	2	2	1	1	2	2	3	2	2	2	2
CO3	3	1	2	1	2	2	2	3	2	2	2	2
CO4	3	1	-	1	1	2	2	3	2	3	2	2
CO5	3	1	-	1	1	2	2	3	2	3	2	2

Detailed Syllabus:

PART-A

UNIT I

ਪੈਂਤੀ ਅੱਖਰੀ (ਵਰਣਮਾਲਾ), ਅੱਖਰ ਕ੍ਰਮ
ਮਾਤਰਾਵਾਂ : ਮੁਢਲੀ ਜਾਣ-ਪਛਾਣ
ਲਗਾਖਰ :ਬਿੰਦੀ, ਟਿੱਪੀ, ਅੱਧਕ

UNIT-II

ਪੰਜਾਬੀ ਸ਼ਬਦ ਬਣਤਰ: ਮੁਢਲੀ ਜਾਣ-ਪਛਾਣ
ਮੂਲ ਸ਼ਬਦ , ਅਗੇਤਰ, ਪਿਛੇਤਰ
ਸਮਾਨਾਰਥਕ ਸ਼ਬਦ, ਵਿਰੋਧਾਰਥਕ ਸ਼ਬਦ

ਸ਼ੁੱਧ- ਅਸ਼ੁੱਧ: ਦਿੱਤੇ ਪੈਰ੍ਹੇ ਵਿੱਚੋਂ ਅਸ਼ੁੱਧ ਸ਼ਬਦ ਨੂੰ ਸ਼ੁੱਧ ਕਰਨਾ (11 Lectures)

PART-B

UNIT-III

ਹਫਤੇ ਦੇ ਸੱਤ ਦਿਨਾਂ ਦੇ ਨਾਂ
ਬਾਰ੍ਹਾਂ ਮਹੀਨਿਆਂ ਦੇ ਨਾਂ
ਰੁੱਤਾਂ ਦੇ ਨਾਂ
ਇਕ ਸੌ ਤੱਕ ਗਿਣਤੀ ਸ਼ਬਦਾਂ ਵਿਚ

UNIT-IV

ਸਧਾਰਣ ਸ਼ਬਦਾਂ ਦਾ ਅੰਗਰੇਜ਼ੀ ਤੋਂ ਪੰਜਾਬੀ ਅਨੁਵਾਦ
ਸਧਾਰਣ ਸ਼ਬਦਾਂ ਦਾ ਪੰਜਾਬੀ ਤੋਂ ਅੰਗਰੇਜ਼ੀ ਅਨੁਵਾਦ

TEXT AND REFERENCE BOOK

1.ਸੰਪ.ਡਾ.ਮਹਿਲ ਸਿੰਘ, ਸਾਹਿਤ ਦੇ ਰੰਗ, ਰਵੀ ਸਾਹਿਤ ਪ੍ਰਕਾਸ਼ਨ, ਅੰਮ੍ਰਿਤਸਰ, 2016.

SEMESTER -II

PHYSICS-C-3	**BSPH-121-21**	**Waves and Vibrations**	**L-3, T-1, P-0**	**4 Credits**

Pre-requisite: Understanding of senior secondary level physics and Mathematics

Course Objectives: The objective of the course provides an exposure about simple harmonic motions, damped harmonic motions and forced oscillations. Students learns about the different waves, propagation of waves in various mediums and reflection/transmission of waves at the interface of mediums.

Course Outcomes: At the end of the course, the student will be able to

CO1	Understand the simple and damped harmonic motion of an oscillator.
CO2	Understand Forced Vibrations and phenomenon of Resonance
CO3	Apply the Coupled oscillator to the real-life problems.
CO4	Understand the transmission of signals and Electromagnetic Waves
CO5	Apply the knowledge obtained in this course to day-to-day problems.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	-	1	-	1	2	-	2	3	2	3
CO2	2	2	1	2	1	1	1	-	1	3	2	3
CO3	3	2	-	2	1	1	2	-	1	3	2	3
CO4	2	2	-	2	1	1	2	1	1	3	3	1
CO5	2	2	-	2	1	1	2	1	1	3	3	3

Detailed Syllabus:

PART-A

UNIT-I

Simple and Damped Harmonic Motion: Simple harmonic motion, energy of a SHO, Compound pendulum, Torsional pendulum, Electrical Oscillations, Lattice Vibrations, Transverse Vibrations of a mass on a string, Anharmonic Oscillations. Damped simple harmonic motion, Decay of free Vibrations due to damping, types of damping, Determination of damping coefficients: Logarithmic decrement, relaxation time and Q-factor. Electromagnetic damping.

(12 Lectures)

UNIT-II

Forced Vibrations and Resonance: Forced mechanical and electrical oscillator, Transient and Steady State Oscillations, Displacement and velocity variation with driving force frequency, Variation of phase with frequency resonance, Power supplied to forced oscillator by the driving force. Q-factor and band width of a forced oscillator, Electrical and nuclear magnetic resonances. (12 lectures)

PART-B

UNIT-III

Coupled Oscillations: Stiffness coupled oscillators, Normal coordinates, and modes of vibrations. Inductance coupling of electrical oscillators, Normal frequencies, forced vibrations and resonance for coupled oscillators, Masses on string-coupled oscillators.

Waves in Physical Media: Types of waves, wave equation (transverse) and its solution characteristics impedance of a string, Impedance matching, Reflection and Transmission of waves at boundary, Energy of vibrating string, wave, and group velocity. (12 Lectures)

UNIT-IV

Transmission of signals and Electromagnetic Waves: Transmission of a non-monochromatic wave, Frequency range and Signal duration, Bandwidth theorem, Group and phase velocities, Electromagnetic theory of dispersion, Doppler effect, Electromagnetic (EM) Waves: Maxwell Equations, Wave equation, EM waves in a medium of finite ε, μ and σ. Energy flow due to a plane EM wave, EM waves in a conducting medium, Skin depth. (12 Lectures)

Text and Reference Books:

1. Text Book of Vibrations and Waves: S.P. Puri (Macmillan India), 2004.
2. The Physics of Vibrations and Waves: H.J. Pain (Wiley and ELBS), 2013.
3. N.K. Bajaj, The Physics of Waves and Oscillations, Tata McGraw Hill, 1998.

PHYSICS-C-4	**BSHP-122-21**	**Electricity and Magnetism**	**L-3, T-1, P-0**	**4 Credits**

Pre-requisite: Basic knowledge of Electricity and Magnetism at high school level.

Course Objectives: The objective of the course is to expose the students to the formal structure of electricity and magnetism so that they can use these as per their requirement.

Course Outcomes: At the end of the course, the student will be able to

CO1	Understand and describe the different concepts of electrostatics and magnetostatics
CO2	Apply the knowledge of Maxwell's equation and flow of electromagnetic waves in real problems.
CO3	Analyze the wave propagation in different media
CO4	Compare the different types of polarization
CO5	have a solid foundation in electromagnetism fundamentals required to solve problems

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	2	2	2	1	2	1	2	3	2	2
CO2	3	2	1	-	2	2	1	1	1	3	1	1
CO3	3	2	3	-	2	1	2	1	1	3	1	1
CO4	3	2	3	2	-	2	2	1	1	3	1	1
CO5	2	2	3	2	-	2	2	1	1	3	1	1

Detailed Syllabus:

PART-A

UNIT I

Review of Vector Analysis and Electrostatics: scalar and vector product; gradient, divergence and curl and their significance; Gauss-divergence theorem and Stoke's theorem (statement only); Electrostatic field; electric flux; Gauss's law of electrostatics; Applications of Gauss law-Electric filed due to point charge, infinite line of charge, uniformly charged spherical shell and solid sphere, plane charge sheet; Electric potential as line integral of electric field, potential due to point charge and electric dipole; calculation of electric field from potential; Poisson's equation and Laplace's equation(Cartesian coordinate); Capacitance; capacitance of a spherical conductor and cylindrical capacitor, Energy per unit volume in electrostatic field, Dielectric medium, dielectric polarization and its types, Displacement vector, Boundary conditions *(11 Lectures)*

UNIT-II

Magnetostatics: Magnetic flux; magnetic flux density; Faraday's law; magnetomotive force; Biot-Savart's law and its applications-straight conductor, circular coil, divergence and curl of magnetic field; Ampere's work law in differential form; Magnetic vector potential; ampere's force law; magnetic vector potential; Energy stored in a magnetic field, boundary conditions on magnetic fields. *(10 Lectures)*

PART-B

UNIT-III

Maxwell's Equations and Poynting Vector: Equation of continuity for time varying fields; Inconsistency of ampere's law; concept of sinusoidal time variations (Phasor notation); Maxwell's equations with physical significance; Maxwell equations in free space, static field and in Phasor notation; Difference between displacement current and conduction current; Concept of Poynting vector; Poynting Theorem. *(11 Lectures)*

UNIT-IV

Electromagnetic Waves: Wave equation in free space or non-conducting or lossless medium; wave equation for conducting medium; wave propagation in lossless and conducting medium (phasor form); Propagation characteristics of EM waves in free space, lossless and in conducting medium; Uniform plane waves and solution; relation between electric and magnetic fields of an electromagnetic wave; Linear, circular and elliptical polarization; depth of penetration, Reflection of waves by a perfect conductor: normal incidence and oblique incidence; Reflection and transmission of electromagnetic waves from a non-conducting medium-vacuum interface for normal incidence. *(12 Lectures)*

Reference Books:

1. David Griffiths, Introduction to Electrodynamics, Pearson Education India Learning Private Limited; 4th edition.
2. Edward C Jordan and Keith G Balmain, Electromagnetic waves and radiating systems, Prentice Hall
3. Kraus John D, Electromagnetics, McGraw-Hill Publisher
4. W. Saslow, Electricity, magnetism and light, Academic Press

5. A Textbook of Electricity and Magnetism, S K Sharma, Shalini Sharma, Publisher: S Dinesh & Co.

PHYSICS -C	**BSHP-123-21**	**Physics Lab-II**	**L-0, T-0, P-4**	**2 Credits**

Pre-requisites (if any): High-school education with Physics lab as one of the subjects.

Course Objectives: The aim and objective of the Physics Lab course is to introduce the students of B. Sc. (Hons.) Physics to the formal structure of wave and vibrations and mechanics so that they can use these as per their requirement.

Course Outcomes: At the end of the course, the student will be

CO1	Able to understand the theoretical concepts learned in the theory course.
CO2	Trained in carrying out precise measurements and handling equipment.
CO3	Learn to draw conclusions from data and develop skills in experimental design.
CO4	Able to understand the principles of error analysis and develop skills in experimental design.
CO5	Able to document a technical report which communicates scientific information in a clear and concise manner.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	2	1	2	1	2	3	2	3
CO2	3	3	1	-	2	2	1	1	1	3	2	3
CO3	3	3	2	-	2	1	2	1	1	3	2	3
CO4	3	2	2	2	-	2	2	1	1	3	2	3
CO5	2	2	2	2	-	2	2	1	1	3	2	3

Note: Students are expected to perform about 8-10 experiments from the following list, selecting minimum of 6-7 from the Physical Lab and 2-3 from the Virtual lab.

List of experiments:

1. Measurements of length (or diameter) using vernier caliper and screw gauge.
2. Measurement of volume using travelling microscope. Use of Plumb line and Spirit level.
3. To determine the frequency of an electrically maintained tuning fork in a) Transverse mode of vibration b) Longitudinal mode of vibration.
4. To verify the law of vibrating string Using Melde's experiment.
5. To compare mass per unit length of two strings by Melde's experiment.
6. To find out the frequency of AC mains using electric-vibrator/sonometer.
7. To determine the horizontal and vertical distance between two points using a Sextant.
8. To determine the height of an inaccessible object using a Sextant.
9. To determine the angular diameter of the sun using the sextant.
10. To determine the angular acceleration α, torque τ, and Moment of Inertia of flywheel.
11. To study the Motion of a Spring and calculate (a) Spring Constant (b) Value of **g** and (c) Modulus of rigidity.
12. To determine the time-period of a simple pendulum for different length and acceleration due to gravity.
13. To study the variation of time-period with distance between centre of suspension and centre of gravity for a compound pendulum and to determine: (i) Radius of gyration of the bar about an axis through its C.G. and perpendicular to its length. (ii) The value of g in the laboratory.
14. To find the moment of inertia of an irregular body about an axis through its C.G with the torsional pendulum.

Reference book and suggested readings:

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practical's, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
3. A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Edn, 2011, Kitab Mahal.
4. Engineering Practical Physics, S. Panigrahi & B. Mallick, 2015, Cengage Learning India Pvt. Ltd.
5. Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University Press.
6. Practical Physics, C L Arora. S. Chand & Company Ltd.
7. http://www.vlab.co.in

General Elective (GE)-3	**BSHM-204-21**	**Vector Algebra & Vector Analysis**	**L-4, T-1, P-0**	**4 Credits**

Pre-requisite: Elementary calculus of matric level.

Course Objectives: The objectives of this course are to make the students understand the following:

1. The fundamental concepts of Scalars and Vector algebra.
2. The geometrical meaning of projections and orthogonality.
3. Applications of gradient, divergence and curl.
4. Geometric meaning of scalar and vector valued functions, gradient of scalar point function.
5. The utility of Gauss, Green and Stokes Theorem.

Course Outcomes: At the end of the course, the student will be able to

CO1	Understand the basic concepts of Scalars and Vector algebra.
CO2	Visualize all concepts geometrically.
CO3	Apply the knowledge of dot product and cross product in finding projections, area and orthogonality.
CO4	Utilize the concept of scalar and vector valued functions, gradient of scalar point function, divergence and curl of vector point functions, their geometrical interpretation.
CO5	Acquire the knowledge of the concept of relation between cartesian, cylindrical and spherical polar coordinates, Gauss, Green and Stokes theorem.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	2	2	2	2	3	2	3	2	2
CO2	2	2	2	1	1	2	2	3	2	3	2	2
CO3	3	2	2	1	2	2	2	3	3	3	2	2
CO4	3	2	-	1	1	2	2	3	2	3	2	2
CO5	3	1	-	1	1	2	2	3	2	3	2	2

Detailed Syllabus:

PART-A

UNIT I

Definitions of Scalars, vectors, position vector, unit vector, types of vectors, Addition of vectors, direction ratios, direction cosines, multiplication by a scalar, dot product, cross product of vectors, projection of vectors on a line.

UNIT-II

Vector joining two points, section formula, angle between two vectors, Cauchy-Schwartz inequality, Solenoidal vectors, orthogonality, Area of triangle, area of parallelogram, Scalar and vector product of three vectors

PART-B

UNIT-III

Scalar valued point functions, vector valued point functions, Derivative along a curve, directional derivatives, Differentiation and partial differentiation of a vector function. Derivative of sum, dot product and cross product of two vectors, Gradient, divergence and curl Gradient of a scalar point function. Geometrical interpretation of gradient of a scalar point function (grad φ).

UNIT-IV

Divergence and curl of a vector point function, Character of divergence and curl of a vector point function, relation between Cartesian and cylindrical or spherical coordinates, Statements of Theorems of Gauss, Green and Stokes (without proof).

TEXT AND REFERENCE BOOK

1. Mathematics, A Text-book for Class XII (Parts I & II), New Delhi: NCERT, 2003. (Unit I & II)
2. G.B. Thomas and R.L. Finney, Calculus, 9th Ed., Pearson Education, Delhi, 2005.
3. H. Anton, I. Bivens and S. Davis, Calculus, John Wiley and Sons (Asia) P. Ltd. 2002.
4. P.C. Matthew's, Vector Calculus, Springer Verlag London Limited, 1998.

General Elective (GE)-4	BHCL-114-21	ORGANIC CHEMISTRY	L-3, T-1, P-0	4 Credits

Pre-requisite: Understanding of senior secondary level chemistry

Course Objectives:

1. To teach the basic principles, reaction mechanisms and stereochemistry of organic compounds.
2. To impart knowledge regarding physical properties and chemical reactions of alkanes, alkenes, dienes, alkynes, arenes, alkyl and aryl halides etc.
3. To predict and account for the most commonly encountered reaction mechanisms (substitution, addition, and elimination) in organic chemistry.

Course Outcomes: At the end of the course, the student will be able to

CO1	Understand the fundamental concepts of organic chemistry i.e. structure, bonding and various effects in organic compounds.
CO2	learn the stereochemistry viz. optical isomerism, stereoisomerism and conformational isomerism of organic compounds.
CO3	study the various known reactive intermediate in organic synthesis.
CO4	learn the fundamental and advanced concepts of reaction mechanisms along with the study of reaction mechanisms in various types of substitution addition and elimination reactions.
CO5	predict the relationships between organic chemical structures and their reactivity.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	2	2	3	2	3	2	3	2	2
CO2	2	2	2	1	1	3	2	3	2	2	2	2
CO3	3	1	2	1	2	2	2	3	2	2	2	2
CO4	3	2	2	1	1	2	2	3	2	3	2	2
CO5	3	1	1	1	1	2	2	3	2	3	2	2

Detailed Syllabus:

PART-A

Unit-I

Basics of Organic Chemistry

Organic Compounds: Classification, and Nomenclature, Hybridization, Shapes of molecules, Influence of hybridization on bond properties. *Electronic Displacements:* Inductive, electromeric, resonance and mesomeric effects, hyperconjugation and their applications; Dipole moment; Organic acids and bases; their relative strength. Homolytic and Heterolytic fission with suitable examples. Curly arrow rules, formal charges; Electrophiles and Nucleophiles; Nucleo phlicity and basicity; Types, shape and their relative stability of Carbocations, Carbanions, Free radicals and Carbenes. Introduction to types of organic reactions and their mechanism: Addition, Elimination

and Substitution reactions.

Unit-II

Stereochemistry:

Fischer Projection, Newmann and Sawhorse Projection formulae and their interconversions; Geometrical isomerism: cis–trans and, syn-anti isomerism E/Z notations with C.I.P rules.

Optical Isomerism: Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, Molecules with two or more chiral-centres, Distereoisomers, meso structures, Racemicmixture and resolution. Relative and absolute configuration: D/L and R/S designations.

A. Carbon-Carbon sigma bonds formation:-

Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation -relative reactivity and selectivity.

PART-B

Unit-III

Carbon-Carbon pi bonds:

Formation of alkenes and alkynes by elimination reactions, Mechanism of E1, E2, E1cb reactions. Saytzeff and Hofmann eliminations.

Reactions of alkenes: Electrophilic additions their mechanisms (Markownikoff/ AntiMarkownikoff addition), mechanism of oxymercuration-demercuration, hydroboration oxidation, ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation(oxidation). 1,2-and 1,4-addition reactions in conjugated dienes and, Diels-Alder reaction; Allylic and benzylic bromination and mechanism, e.g. propene, 1-butene, toluene, ethyl benzene. *Reactions of alkynes:* Acidity, Electrophilic and Nucleophilic additions. Hydration to form carbonyl compounds, Alkylation of terminal alkynes.

Unit-IV

Cycloalkanes and Conformational Analysis

Types of cycloalkanes and their relative stability, Baeyer strain theory, Conformation analysis of alkanes: Relative stability: Energy diagrams of cyclohexane: Chair, Boat and Twist boat forms; Relative stability with energy diagrams.

Aromatic Hydrocarbons

Aromaticity: Hückel's rule, aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples. Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their mechanism. Directing effects of the groups.

Text and Reference Books:

1. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4. Eliel, E. L. & Wilen, S. H. Stereochemistry of Organic Compounds; Wiley: London, 1994.
5. Kalsi, P. S. Stereochemistry Conformation and Mechanism; New Age International, 2005.

General Elective (GE)-4	**BHCP-116-21**	**CHEMISTRY LAB-II**	**L-0, T-0, P-2**	**2 Credits**

Pre-requisite: Understanding of senior secondary level Chemistry

Course Objectives: which will act as a strong background if he/she chooses to pursue physics as a career.

Course Outcomes: At the end of the course, the student will be able to

CO1	check the purity of organic compounds by determining the melting or boiling points.
CO2	develop preparative skills for purification of organic compounds by crystallization method.
CO3	determine the element or functional groups present in organic compound by organic qualitative analysis.
CO4	present their work with practical skills and the awareness of health and safety procedures.
CO5	apply related experiments for their research work.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	2	2	2	2	3	2	3	2	2
CO2	2	2	2	1	1	2	2	3	2	2	2	2
CO3	3	3	2	1	2	2	2	3	2	2	2	2
CO4	2	3	-	1	1	2	2	3	2	3	2	2
CO5	2	1	1	1	1	2	2	3	2	3	2	2

List of Experiments:

1. Checking the calibration of the thermometer
2. Purification of organic compounds by crystallization using the following solvents: a) Water b) Alcohol, and c) Alcohol-Water.
3. Determination of the melting points of above compounds and unknown organic compounds (Kjeldahl method and electrically heated melting point apparatus)
4. Effect of impurities on the melting point – mixed melting point of two unknown organic compounds
5. Determination of boiling point of liquid compounds. (boiling point lower than and more than 100°C by distillation and capillary method)
6. Chromatography a) Separation of a mixture of two amino acids by ascending and horizontal paper chromatography b) Separation of a mixture of two sugars by ascending paper chromatography, c) Separation of a mixture of o-and p-nitrophenol or o-and p-aminophenol by thin layer chromatography (TLC)

Reference Books

1. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry,* Pearson Education (2009).
2. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. *Practical Organic Chemistry, 5th Ed.,* Pearson (2012).

Ability Enhancement Compulsory (AEC)-3	**BHHL-115-21**	**Communicative English-II**	**L-2, T-0, P-0**	**2 Credits**

Pre-requisite: Basic proficiency in communicative English

Course Objectives: This course is designed to

- help the students become proficient in LSRW-Listening, Speaking, Reading & Writing skills
- help the students become the independent users of English language
- develop in them vital communication skills, integral to their personal, social and professional interactions
- teach them the appropriate language of professional communication
- prepare them for job market

Course Outcomes: At the end of the course, the student will be able to

CO1	Students will acquire basic proficiency in reading &listening, writing and speaking skills.
CO2	Students will be able to understand spoken and written English language, particularly the language of their chosen technical field.
CO3	They will be able to converse fluently.
CO4	They will be able to produce on their own clear and coherent texts.
CO5	Students will become proficient in professional communication such as interviews, group discussions, office environments, important reading skills as well as writing skills and thereby will have better job prospects.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	-	-	1	1	2	2	3	2	3	2	2
CO2	1	-	-	1	1	2	2	3	2	3	2	2
CO3	1	-	**-**	1	1	2	2	3	2	3	2	2
CO4	1	-	-	1	1	2	2	3	2	3	2	2
CO5	2	-	-	1	1	2	2	3	2	3	2	2

Detailed Syllabus:

Part –A

UNIT I-(Literature)

(A) *The Poetic Palette* (Orient Black Swan, Second Edition, 2016)

The following poems from this anthology are prescribed:

1. The Soul's Prayer: Sarojini Naidu
2. I Sit and Look Out: Walt Whitman
3. Women's Rights: Annie Louise Walker

(B) *Prose Parables* (Orient Black Swan, 2013)

The following stories from the above volume are prescribed:

1. The Doctor's Word: R.K. Narayan
2. The Doll's House: Katherine Mansfield
3. Dusk: H.H. Munroe (Saki)

UNIT-II

Vocabulary: Standard abbreviations; One word substitution; Word Pairs (Homophones/ Homonyms)

Grammar: Sentence Structures; Use of phrases and clauses in sentences; Transformation of Sentences; Importance of proper punctuation

PART-B

UNIT-III

Reading and Understanding: Summary Paraphrasing; Analysis and Interpretation; Translation (from Hindi/Punjabi to English and vice-versa)

UNIT-IV

Mechanics of Writing & Speaking Skills: Report writing, Career Documents- Job applications, Resume/CV writing, Common Everyday Situations: Conversations & Dialogues, Formal Presentations

TEXT AND REFERENCE BOOK

1. John Eastwood, Oxford Practice Grammar, Oxford University Press, 2014
2. Michael Swan, Practical English Usage, OUP. 1995.
3. F.T. Wood, Remedial English Grammar, Macmillan. 2007.
4. William Zinsser, On Writing Well, Harper Resource Book 2001.
5. Sanjay Kumar and Pushp Lata, Oxford University Press. 2011.
6. Communication Skills, Oxford University Press. 2011.
7. Liz Hamp-Lyons and Ben Heasly, Study Writing, Cambridge University Press. 2006.

Ability Enhancement Compulsory (AEC)-4	**BHHL-116A-21**	**ਪੰਜਾਬੀ ਲਾਜ਼ਮੀ (Punjabi Compulsory)-II**	**L-2, T-0, P-0**	**2 Credits**

Pre-requisite: Understanding of senior secondary level Punjabi

Course Objectives: The objective of the course is to enhance the ability of via Learning science and developing science literacy through local language teaching with science subjects.

Course Outcomes: At the end of the course, the student will be able to

CO1	Translate and transfer/broadcast the western scientific knowledge in the local language.
CO2	Translate and transfer the indigenous/traditional scientific knowledge available in local knowledge into English and other global languages.
CO3	Understand the society through Punjabi language, literature and culture
CO4	Learning science and in developing science literacy.
CO5	Improve the internal communication.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	2	2	2	2	3	2	3	2	2
CO2	2	2	2	1	1	2	2	3	2	2	2	2
CO3	3	3	2	1	2	2	2	3	2	2	2	2
CO4	2	3	-	1	1	2	2	3	2	3	2	2
CO5	2	1	1	1	1	2	2	3	2	3	2	2

Detailed Syllabus:

PART-A

UNIT I

ਡਾ.ਹਰਿਭਜਨ ਸਿੰਘ:

ਅਪ੍ਰਮਾਣਿਕ, ਤੇਰੇ ਹਜ਼ੂਰ ਮੇਰੀ ਹਾਜ਼ਰੀ ਦੀ ਦਾਸਤਾਨ

ਸ਼ਿਵ ਕੁਮਾਰ ਬਟਾਲਵੀ:

ਕੰਡਿਆਲੀ ਥੋਰ੍ਹ, ਧਰਮੀ ਬਾਬਲ ਪਾਪ ਕਮਾਇਆ, ਰੁੱਖ

ਪਾਸ਼:

ਇਨਕਾਰ,ਸਭ ਤੋਂ ਖਤਰਨਾਕ,ਦਹਿਕਦੇ ਅੰਗਿਆਰਾਂ 'ਤੇ

ਸੁਰਜੀਤ ਪਾਤਰ:

ਹੁਣ ਘਰਾਂ ਨੂੰ ਪਰਤਣਾ, ਕੁਝ ਕਿਹਾ ਤਾਂ..., ਪੁਲ *(Lecture 12)*

UNIT-II

ਕਹਾਣੀ ਭਾਗ:

ਸੰਤੋਖ ਸਿੰਘ ਧੀਰ:

ਕੋਈ ਇਕ ਸਵਾਰ

ਪ੍ਰੇਮ ਪ੍ਰਕਾਸ਼:

ਲੱਛਮੀ

ਮੋਹਨ ਭੰਡਾਰੀ :

ਘੋਟਣਾ

ਵਰਿਆਮ ਸਿੰਘ ਸੰਧੂ :

ਆਪਣਾ ਆਪਣਾ ਹਿੱਸਾ *(Lecture 11)*

PART-B

UNIT-III

ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਦੀਆਂ ਵਿਸ਼ੇਸ਼ਤਾਵਾਂ

ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਉਪਰ ਪਏ ਪ੍ਰਭਾਵ *(Lecture 12)*

UNIT-IV

ਰਿਪੋਰਟਿੰਗ, ਸਮਾਚਾਰ ਲਿਖਣ ਦੀ ਵਿਧੀ ਤੇ ਤੱਤ

ਪੰਜਾਬੀ ਪੈਰ੍ਹੇ ਦਾ ਸਰਲ ਅੰਗਰੇਜ਼ੀ ਅਨੁਵਾਦ

ਦਫਤਰੀ ਚਿੱਠੀ ਪੱਤਰ

TEXT AND REFERENCE BOOK:

1. ਸੰਪ.ਡਾ.ਮਹਿਲ ਸਿੰਘ, ਸਾਹਿਤ ਦੇ ਰੰਗ, ਰਵੀ ਸਾਹਿਤ ਪ੍ਰਕਾਸ਼ਨ, ਅੰਮ੍ਰਿਤਸਰ, 2016.

Ability Enhancement Compulsory (AEC)-4	**BHHL-116B-21**	ਮੁਢਲੀ ਪੰਜਾਬੀ **(Mudhli Punjabi)-II**	**L-2, T-0, P-0**	**2 Credits**

Pre-requisite: Understanding of senior secondary level Physics and Mathematics

Course Objectives: The objective of the course is:
1.To enhance the language ability of students.
2.To enhance the ability of Learning science and developing science literacy through local language teaching with science subjects.

Course Outcomes: At the end of the course, the student will be able to

CO1	Translate and transfer/broadcast the western scientific knowledge in the local language.
CO2	Translate and transfer the indigenous/traditional scientific knowledge available in local knowledge into English and other global languages.
CO3	Understand the society through Punjabi language, literature and culture.
CO4	Learning science and in developing science literacy.
CO5	Improve the internal communication.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	2	2	2	2	3	2	3	2	2
CO2	2	2	2	1	1	2	2	3	2	2	2	2
CO3	3	3	2	1	2	2	2	3	2	2	2	2
CO4	2	3	-	1	1	2	2	3	2	3	2	2
CO5	2	1	1	1	1	2	2	3	2	3	2	2

Detailed Syllabus:

PART-A

UNIT I

ਸ਼ਬਦ ਸ਼੍ਰੇਣੀਆਂ : ਪਛਾਣ ਤੇ ਵਰਤੋਂ-
ਨਾਂਵ
ਪੜਨਾਂਵ
ਵਿਸ਼ੇਸ਼ਣ
ਕਿਰਿਆ
ਕਿਰਿਆ ਵਿਸ਼ੇਸ਼ਣ (12 Lectures)

UNIT-II

ਰੋਜ਼ਾਨਾ ਵਰਤੋਂ ਦੀ ਪੰਜਾਬੀ ਸ਼ਬਦਾਵਲੀ:
ਬਾਜ਼ਾਰ, ਵਪਾਰ, ਰਿਸ਼ਤੇ-ਨਾਤੇ ਤੇ ਕਿੱਤਿਆਂ ਸਬੰਧੀ। (12 Lectures)

PART-B

UNIT-III

ਪੰਜਾਬੀ ਵਾਕ ਬਣਤਰ :
ਸਧਾਰਣ ਵਾਕ
ਸੰਯੁਕਤ ਵਾਕ
ਮਿਸ਼ਰਤ ਵਾਕ

(12 Lectures)

UNIT-IV

ਸਧਾਰਣ ਵਾਕਾਂ ਦਾ ਅੰਗਰੇਜ਼ੀ ਤੋਂ ਪੰਜਾਬੀ ਅਨੁਵਾਦ
ਸਧਾਰਣ ਵਾਕਾਂ ਦਾ ਪੰਜਾਬੀ ਤੋਂ ਅੰਗਰੇਜ਼ੀ ਅਨੁਵਾਦ (11 Lectures)

TEXT AND REFERENCE BOOK:

1. ਸੰਪ.ਡਾ.ਮਹਿਲ ਸਿੰਘ, ਸਾਹਿਤ ਦੇ ਰੰਗ, ਰਵੀ ਸਾਹਿਤ ਪ੍ਰਕਾਸ਼ਨ, ਅੰਮ੍ਰਿਤਸਰ, 2016.

SEMESTER-III

PHYSICS-C-5	**BSHP-211-21**	**Mathematical Physics-I**	**L-5, T-1, P-0**	**6 Credits**

Pre-requisite: Understanding of senior secondary level Physics and Mathematics

Course Objectives: *The emphasis of the course is on applications in handling problems of physics. Students to be examined based on problem solving capabilities.*

Course Outcomes: At the end of the course, the student will be able to

CO1	Understand maths of complex number and application of Cauchy-Riemann Equations, Residue Theorem and Taylor Series for analytic functions.
CO2	apply numerical methods to solve physics problems.
CO3	Solve differential equations like Legendre, Bessel and Hermite polynomial that are common in physical sciences.
CO4	Understand probability and error propagation methods
CO5	Utilize special function such as beta, gamma, and Dirac Delta.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	1	-	1	2	1	2	3	2	2
CO2	3	2	1	1	1	1	1	1	1	3	1	1
CO3	3	2	2	2	3	1	2	1	1	3	1	1
CO4	3	2	2	2	1	1	2	1	1	3	1	1
CO5	2	2	2	2	1	1	2	1	1	3	1	1

Detailed Syllabus:

PART-A

UNIT -I

Complex Analysis-I: Brief Revision of Complex Numbers and their Graphical Representation. Euler's formula, De Moivre's theorem, Roots of Complex Numbers. Functions of Complex Variables. Analyticity and Cauchy-Riemann Conditions. Examples of analytic functions. Singular functions: poles and branch points, order of singularity, Cauchy's Integral formula. Simply and multiply connected region. Laurent and Taylor's expansion. Residues and Residue Theorem.

(15 Lectures)

UNIT -II

Numerical methods: Solution of Algebraic and Transcendental Equations: Fixed-point Iteration Method, Bisection Method, Secant Method, Newton Raphson Method, and Generalized Newton's Method, Comparison and Error Estimation.

Matrices and Linear System of Equations: Solution of Linear Equations: Gauss Elimination Method, Gauss Seidel Iterative Method, Computation of Eigen values and Eigenvectors of Matrices by using Iterative Methods. **(15 Lectures)**

PART-B

UNIT -III

Introduction to probability: Independent random variables: Probability distribution functions; binomial, Gaussian, and Poisson, with examples. Mean and variance. Dependent events: Conditional Probability. Bayes' Theorem and the idea of hypothesis testing.

Theory of Errors: Systematic and Random Errors. Propagation of Errors. Normal Law of Errors. Standard and Probable Error. Least square fit. Error on the slope and intercept of a fitted line.

(15 Lectures)

UNIT-IV

Some Special Integrals: Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions. Error Function (Probability Integral).

Dirac Delta function and its properties: Definition of Dirac delta function. Representation as limit of a Gaussian function and rectangular function. Properties of Dirac delta function.

(15 Lectures)

Text and Reference Books:

1. 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, E.A Coddington, 1961, PHI Learning
5. Differential Equations, George F. Simmons, 2006, Tata McGraw-Hill.
6. Partial Differential Equations for Scientists and Engineers, S.J. Farlow, 1993, Dover Publications.
7. Mathematical methods for Scientists & Engineers, D.A. McQuarrie, 2003, Viva Books.

PHYSICS-C-6	**BSHP-212-21**	**ELEMENTS OF MODERN PHYSICS**	**L-3, T-1, P-0**	**4 Credits**

Pre-requisite: Understanding of senior secondary level Physics and Mathematics

Course Objectives: *The course content covers foundations of modern physics, experiments forming basis of quantum mechanics, Schrodinger equation and applications, uncertainty principle and applications. The topics covered in the course build a foundation of undergraduate physics students to study the advance branches: quantum physics, nuclear physics, particle physics and high energy physics.*

Course Outcomes: At the end of the course, the student will be able to

CO1	Understand the implication of special theory of relativity.
CO2	Understand and explain the differences between classical and quantum mechanics.
CO3	Identify properties of the nucleus and other sub-atomic particles.
CO4	Assess whether a solution to a given problem is physically reasonable and solve Schrodinger equation for simple potentials.
CO5	Describe theories explaining the structure of atoms and the origin of the observed spectra.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	1	-	1	2	1	2	3	2	2
CO2	2	2	1	2	1	1	1	1	1	3	1	1
CO3	3	2	2	2	1	1	2	1	1	3	1	1
CO4	2	2	2	2	1	1	2	1	1	3	1	1
CO5	2	2	2	2	1	1	2	1	1	3	1	1

Detailed Syllabus:

PART-A

UNIT -I

Special Theory of Relativity: Michelson-Morley Experiment and its outcome, Postulates of Special Theory of Relativity, Lorentz Transformations. Simultaneity and order of events, Lorentz contraction, Time dilation. Relativistic transformation of velocity, frequency, and wave number.

Relativistic addition of velocities. Variation of mass with velocity, Massless Particles, Mass-energy Equivalence. Relativistic Doppler effect, Relativistic Kinematics. Transformation of Energy and Momentum. Energy-Momentum Four Vector. **(10 Lectures)**

UNIT-II

Particle Properties of Waves: Electromagnetic waves, Blackbody Radiation, ultraviolet catastrophe, Rayleigh-Jeans formula, Planck radiation hypothesis, Photoelectric Effect, Compton Scattering, Quantum theory of light: wave and particle nature, X-Rays, X-Ray Diffraction, determination of wavelengths using Compton Effect, Pair-Production. **(10 Lectures)**

PART-B

UNIT-III

Dual Nature of Waves and Particles: Waves of probability, Description of a Waves in general, Group and Phase velocities and relation between them, De Broglie wavelength, wave-particle duality, Matter waves, Davisson-Germer experiment, Two-Slit experiment with electrons, gamma ray microscope thought experiment, Heisenberg uncertainty principle: Derivation and applications-impossibility of a particle following a trajectory, estimating minimum energy of a confined particle; Energy-time uncertainty principle-application to virtual particles and range of interaction.

(10 Lectures)

UNIT-IV

Introduction to Quantum mechanics: Need for Quantum mechanics, Wave description of particles by wave packets, Physical interpretation of a wave function: Born interpretation, probabilities, and normalization time-dependent and time-independent Schrodinger equation for wave function, Solution of stationary-state Schrodinger equation for one dimensional problems: particle in a box. **(10 Lectures)**

Text and Reference Books:

1. 1. Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.

2. Introduction to Quantum Mechanics, David J. Griffith, 2005, Pearson Education.

3. Introduction to Modern Physics, Rich Meyer, Kennard, Coop, 2002, Tata McGraw Hill.

4. Physics for Scientists and Engineers with Modern Physics, Jewett and Serway, 2010, Cengage Learning.

5. Modern Physics, G.Kaur and G.R. Pickrell, 2014, McGraw Hill.

6. Quantum Mechanics: Theory & Applications, A.K.Ghatak & S.Lokanathan, 2004, Macmillan.

7. Modern Physics, J.R. Taylor, C.D. Zafiratos, M.A. Dubson, 2004, PHI Learning.

8. Theory and Problems of Modern Physics, Schaum's outline, R. Gautreau and W. Savin, 2nd Edn, Tata

McGraw-Hill Publishing Co. Ltd.

9. Quantum Physics, Berkeley Physics, Vol.4. E.H.Wichman, 1971, Tata McGraw-Hill Co.

10. Basic ideas and concepts in Nuclear Physics, K.Heyde, 3rd Edn., Institute of Physics Pub.

11. Six Ideas that Shaped Physics: Particle Behave like Waves, T.A.Moore, 2003, McGraw Hill.

PHYSICS-C	**BSHP-213-21**	**PHYSICS LAB-III**	**L-0, T-0, P-4**	**2 Credits**

Pre-requisite: Understanding of senior secondary level Physics and Mathematics

Course Objectives: *The laboratory experiments forming basis of quantum mechanics, photoelectric effect, ionization potential, absorption and emission spectra, diffraction, and tunneling effect.*

Course Outcomes: At the end of the course, the student will be able to

CO1	Able to verify the theoretical concepts/laws learnt in theory courses.
CO2	Trained in carrying out precise measurements and handling sensitive equipment.
CO3	Understand the methods used for estimating and dealing with experimental uncertainties and systematic "errors".
CO4	Learn to draw conclusions from data and develop skills in experimental design.
CO5	Document a technical report which communicates scientific information in a clear and concise manner.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	1	2	2	2	1	2	3	2	2
CO2	2	2	3	2	1	1	1	1	1	3	2	2
CO3	3	2	2	2	1	3	2	1	1	3	2	2
CO4	2	2	2	2	3	1	2	1	1	3	1	1
CO5	2	2	2	2	1	1	2	1	1	3	1	1

Detailed Syllabus:

Note: Students are expected to perform 8-10 experiments from the list taking at least 2-3 from the virtual lab.

List of experiment:

1. Measurement of Planck's constant using black body radiation and photo-detector.
2. Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photoelectrons versus frequency of light.
3. To determine work function of material of filament of directly heated vacuum diode.
4. To determine the Planck's constant using LEDs of at least 4 different colours.
5. To determine the wavelength of H-alpha emission line of Hydrogen atom.
6. To determine the ionization potential of mercury.
7. To determine the absorption lines in the rotational spectrum of Iodine vapour.
8. To determine the value of e/m by (a) Magnetic focusing or (b) Bar magnet.
9. To setup the Millikan oil drop apparatus and determine the charge of an electron.
10. To show the tunneling effect in tunnel diode using I-V characteristics.
11. To determine (i) wavelength and (ii) angular spread of a laser using plane diffraction grating.
12. Dependence of scattering angle on kinetic energy and impact parameter in Rutherford scattering (mechanical analogue).
13. Measurement of the electrical and thermal conductivity of copper to determine its Lorentz number.
14. To determine energy band gap of a given semiconductor.

Reference Books:

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
3. A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Edn, 2011, Kitab Mahal.

PHYSICS-C-7	**BSHP-214-21**	**ANALOG ELECTRONICS**	**L-3, T-1, P-0**	**4 Credits**

Pre-requisite: Understanding of senior secondary level Physics and Mathematics

Course Objectives: *The course content covers basic semiconductor physics and devices, diodes, bipolar junction transistors, amplifiers, feedback concepts, Operation amplifiers and applications.*

Course Outcomes: At the end of the course, the student will be able to

CO1	Illustrate working principle of different electronic circuit and their applications in real life.
CO2	Understand the working of semiconductor device and different operating condition and their performance parameter.
CO3	Design and analyse the different types of amplifiers and understand the feedback mechanism.
CO4	Design and analyse the different types of oscillators.
CO5	Recognize different signal processing circuit and the use in industrial, real life, modern control system application.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	1	-	1	2	1	2	3	2	2
CO2	2	2	1	2	1	1	1	1	1	3	1	1
CO3	3	2	2	2	1	1	2	1	1	3	1	1
CO4	2	2	2	2	1	1	2	1	1	3	1	1
CO5	2	2	2	2	1	1	2	1	1	3	1	1

Detailed Syllabus:

PART-A

UNIT-I

Semiconductor Diodes: P and N type semiconductors. Energy Level Diagram. Conductivity and Mobility, Barrier Formation in PN Junction Diode. Static and Dynamic Resistance. Current Flow Mechanism in Forward and Reverse Biased Diode. Drift Velocity. Derivation for Barrier Potential, Barrier Width and Current for Step Junction. Current Flow Mechanism in Forward and Reverse Biased Diode. **(10 Lectures)**

UNIT-II

Two-terminal Devices and their Applications: (1) Rectifier Diode: Half-wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers, Calculation of Ripple Factor and Rectification Efficiency, C-filter (2) Zener Diode and Voltage Regulation. Principle and structure of (1) LEDs, (2) Photodiode and (3) Solar Cell.

Bipolar Junction transistors: n-p-n and p-n-p Transistors. Characteristics of CB, CE and CC Configurations. Current gains α and β Relations between α and β. Load Line analysis of Transistors. DC Load line and Q-point. Physical Mechanism of Current Flow. Active, Cutoff and Saturation Regions. **(12 Lectures)**

PART-B

UNIT-III

Amplifiers: Transistor Biasing and Stabilization Circuits. Fixed Bias and Voltage Divider Bias. Transistor as 2-port Network. h-parameter Equivalent Circuit. Analysis of a single-stage CE amplifier using Hybrid Model. Input and Output Impedance. Current, Voltage and Power Gains. Classification of Class A, B & C Amplifiers. Coupled Amplifier: Two stage RC-coupled amplifier and its frequency response. **(10 Lectures)**

UNIT-IV

Oscillators: Introduction, Types of oscillators, Fundamental principle of oscillators, Feedback oscillators, Tunes collector oscillator, Hartley and Colpitts Oscillator, Phase shift oscillator, Wein bridge oscillator, crystal oscillators. **(9 Lectures)**

Reference Books:

1. Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
2. Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.
3. Solid State Electronic Devices, B. G. Streetman & S. K. Banerjee, 6th Edn.,2009, PHI Learning
4. Electronic Devices & circuits, S. Salivahanan & N. S. Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill
5. OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall
6. Microelectronic circuits, A.S. Sedra, K.C. Smith, A.N. Chandorkar, 2014, 6th Edn, Oxford University Press.
7. Electronic circuits: Handbook of design & applications, U.Tietze, C.Schenk,2008, Springer
8. Semiconductor Devices: Physics and Technology, S.M. Sze, 2nd Edn., 2002, Wiley India
9. Microelectronic Circuits, M.H. Rashid, 2nd Edition, Cengage Learning
10. Electronic Devices, 7th edn. Thomas L. Floyd, 2008, Pearson India

PHYSICS-C	**BSHP-215-21**	**PHYSICS LAB-IV**	**L-0, T-0, P-4**	**2 Credits**

Pre-requisite: Understanding of senior secondary level Physics and Mathematics

Course Objectives: *The laboratory exercises have been so designed that the students learn to study characteristics of various diodes, solar cells, and BJT and their biasing aspects, amplifiers, oscillators, ADC and DAC based application circuits.*

Course Outcomes: At the end of the course, the student will be able to

CO1	Illustrate working principle of different electronic circuit and their applications in real life.
CO2	Understand the working of semiconductor device and different operating condition and their performance parameter.
CO3	Design and analyse the different types of amplifiers and understand the feedback mechanism.
CO4	Design and analyse the different types of oscillators.
CO5	Recognize different signal processing circuit and the use in industrial, real life, modern control system application.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	1	2	3	2	1	2	3	2	3
CO2	2	2	1	2	1	3	1	1	1	3	1	3
CO3	3	2	2	2	1	3	2	1	1	3	2	2
CO4	2	2	2	2	1	3	2	1	1	3	2	2
CO5	2	2	2	2	1	3	2	1	1	3	1	3

Detailed Syllabus:

Note: Students are expected to perform 8-10 experiments from the list taking at least 2-3 from the virtual lab.

1. To study I-V characteristics of different diodes - Ge, Si, LED and Zener.
2. To study voltage regulation and ripple factor for a half-wave and a full-wave rectifier without and with different filters. Use of Zener diode and IC regulators.
3. To study common emitter characteristics of a given transistor and to determine various parameters.
4. Study of I-V & power curves of solar cells and find maximum power point & efficiency.
5. To design a CE transistor amplifier of a given gain (mid-gain) using voltage divider bias.
6. To study the frequency response of voltage gain of a RC-coupled transistor amplifier.
7. To design a Wien bridge oscillator for given frequency using an op-amp.
8. To design a phase shift oscillator of given specifications using BJT.
9. To study the Colpitts's oscillator.
10. To design a digital to analog converter (DAC) of given specifications.
11. To study the analog to digital convertor (ADC) IC.
12. To design an inverting amplifier using Op-amp (741,351) for dc voltage of given gain and study its frequency response.
13. To draw the characteristics of a given triode and to determine the tube parameters.
14. Calibration of a Si diode, a thermistor, and thermocouple for temperature measurements.
15. To measure low resistance by Kelvin's double bridge/Carey Foster's bridge.

Reference Books:

1. Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc- Graw Hill.
2. OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall.
3. Electronic Principle, Albert Malvino, 2008, Tata Mc-Graw Hill.
4. Electronic Devices & circuit Theory, R.L. Boylestad & L.D. Nashelsky, 2009, Pearson.

General Elective (GE)-5 Chemistry	**BHCL-204-21**	**Physical Chemistry**	**L-3, T-1, P-0**	**4 Credits**

Pre-requisite: Understanding of senior secondary level chemistry

Course Objectives: *This course will equip students with the necessary knowledge concerning the fundamentals in the basic areas of physical chemistry viz. different states of matter, solutions, and ionic equilibrium. The problem-solving skills of students are expected to be enhanced through due weightage given to numerical problems in each unit.*

Course Outcomes: At the end of the course, the student will be able to

CO1	Understand the basic principles and theories pertaining to different states of matter
CO2	Solve various problems related to pH
CO3	Define the various laws pertaining to gaseous state and solutions.
CO4	Familiarise with the different colligative properties of solutions and the concept of abnormal molecular mass
CO5	Understand the basic structure and symmetry elements in solids

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	1	2	1	2	2	2	3	2	2
CO2	2	2	1	2	1	1	1	2	1	3	1	2
CO3	3	2	2	2	1	1	2	2	2	3	2	2
CO4	2	2	2	2	1	1	2	1	2	3	1	1
CO5	2	2	2	2	1	1	2	1	1	3	1	1

Detailed Syllabus:

PART A

UNIT-I

Gaseous State: The kinetic molecular theory of gases, Postulates and derivation of kinetic gas equation and various gas laws, The ideal gas law: Applications, Behaviour of real gases: Deviations from ideal gas behaviour, compressibility factor, Z and its variation with pressure for different gases. Causes of deviation from ideal behavior. Van der Waals equation of state, its derivation and application in explaining real gas behaviour. Numerical.

UNIT-II

Liquid and Solid State: Physical properties of liquids; vapour pressure, surface tension and coefficient of viscosity and their determination, cleansing action of detergents.

Nature of the solid state, law of constancy of interfacial angles, law of rational indices, Miller indices, elementary ideas of symmetry, symmetry elements and symmetry operations, qualitative idea of point and space groups, seven crystal systems and fourteen Bravais lattices; X-ray diffraction, Bragg's law.

PART B

UNIT-III

Ionic equilibria: Concept of Acids and Bases. Electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect; dissociation constants of mono-, di-and triprotic acids.

Buffer solutions; buffer capacity, buffer range, buffer action

Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.

UNIT-IV

Solutions and Colligative Properties: Ways of expressing the concentration, lowering of vapour pressure, Raoult's Law. Colligative properties (i) relative lowering of vapour pressure, (ii) elevation of boiling point, (iii) Depression of freezing point, (iv) osmotic pressure. Applications in calculating molar masses of normal, dissociated, and associated solutes in solution.

RECOMMENDED BOOKS:

1. P.W. Atkins & J. de Paula, Atkin's Physical Chemistry, Oxford University Press (2006).
2. S.H. Maron & C.F. Prutton, Principles of Physical Chemistry, 1st edition, Oxford and IBH (1958).
3. G.W. Castellan, Physical Chemistry, 4th edition, Narosa (2004)
4. I.N. Levine, Physical Chemistry 6th Ed., Tata Mc Graw Hill (2010)
5. T. Engel & P. Reid, Physical Chemistry 3rd Ed., Prentice-Hall (2012)

General Elective (GE)-5 Chemistry	**BHCP-208-21**	**Chemistry Lab-III**	**L-0, T-0, P-4**	**2 Credits**

Pre-requisite: Understanding of senior secondary level Physics and Mathematics

Course Objectives: To provide students practical knowledge and skills about various topics taught in theory class of physical chemistry, which in turn will enhance their problem solving and analytical skills.

Course Outcomes: At the end of the course, the student will be able to

CO1	Understand the basic procedures for carrying out a physical chemistry practical like preparation and standardization of solutions, handling the equipment and measuring with precision.
CO2	Correlate the theoretical and practical aspects and know about the limits of the experimental error.
CO3	Determine the various physical parameters for the various problems under consideration.
CO4	Verify various laws studied in the theory part.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	1	2	3	2	2	2	3	2	2
CO2	2	2	1	2	1	3	1	2	1	3	1	2
CO3	3	2	2	2	1	3	2	2	2	3	2	2
CO4	2	2	2	2	1	3	2	1	2	3	1	1
CO5	2	2	2	2	1	3	2	1	1	3	1	1

Detailed Syllabus

UNIT-I

Preparation and Standardization of Solutions.

UNIT-II

Surface tension measurements.

a) Determine the surface tension by (i) drop number (ii) drop weight method.

b) Study the variation of surface tension of detergent solutions with concentration.

UNIT-III

Viscosity measurement using Ostwald's viscometer.

a) Determination of viscosity of aqueous solutions of (i) polymer (ii) ethanol and (iii) sugar at room temperature.

b) Study the variation of viscosity of sucrose solution with the concentration of solute.

UNIT-IV

pH metry

a) Study the effect on pH of addition of HCl/NaOH to solutions of acetic acid, sodium acetate and their mixtures.
b) Preparation of buffer solutions of different pH;
(i) Sodium acetate-acetic acid
(ii) Ammonium chloride-ammonium hydroxide
c) pH metric titration of (i) strong acid vs. strong base, (ii) weak acid vs. strong base.
d) Determination of dissociation constant of a weak acid.

Recommended Books

1**.** J.B. Yadav, Practical Physical Chemistry, Krishna
2. Findlay, Practical Physical Chemistry, Longman, New York

PHYSICS-SEC -1	**BSHP-216-21**	**PHYSICS WORKSHOP SKILL**	**L-0, T-1, P-2**	**2 Credits**

Pre-requisite: Understanding of senior secondary level Physics and Mathematics

Course Objectives: *The aim of this course is to enable the students to familiar and experience with various mechanical and electrical tools through hands-on mode, and to improve the abilities of the students to frame and tackle problems in Physics.*

Course Outcomes: At the end of the course, the student will be able to

CO1	Understand the different types of unit's system and their conversion
CO2	Introduced the concept of prime movers.
CO3	Apply the Mechanical Skills and understand the concept of workshop practices.
CO4	Understand the learned concepts to electronics and electrical circuits.
CO5	

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	1	-	1	2	1	2	3	2	2
CO2	2	2	1	2	1	1	1	1	1	3	1	1
CO3	3	2	2	2	1	1	2	1	1	3	1	1
CO4	2	2	2	2	1	1	2	1	1	3	1	1
CO5	2	2	2	2	1	1	2	1	1	3	1	1

Detailed Syllabus:

PART-A

Unit-I

Introduction: Measuring units. conversion to SI and CGS unit system. Familiarization with meter scale, Vernier caliper, Screw gauge and their utilities. Measure the dimension of a solid block, volume of cylindrical beaker/glass, diameter of a thin wire, thickness of metal sheet, etc. Use of Sextant to measure height of buildings, mountains, etc. **(4 Lectures)**

Unit-II

Introduction to prime movers: Gear and gear mechanism, lever and lever mechanism, Brakes and braking mechanism, Pulley and pulley mechanism, power generator system. **(6 Lectures)**

PART-B

Unit-III

Mechanical Skills: Concept of workshop practice. Overview of manufacturing methods: foundry, machining, forming, and welding. Types of welding joints and welding defects. Common materials used for manufacturing like, metals, alloys, and composites. Concept of machine processing, introduction to common machine tools like lathe, shaper, drilling, milling and surface machines. Cutting tools, lubricating oils. Introduction to sheet metal, operations, and job of funnel fabrication. (**5 Lectures)**

Unit-IV

Electrical and Electronic Skill: Use of Multimeter. Soldering of electrical circuits having discrete components (R, L, C, diode) and ICs on PCB. Operation of oscilloscope. Making regulated power supply. Timer circuit, electronic switch using transistor and relay. **(5 Lectures)**

Reference Books:

1. A textbook in Electrical Technology - B L Theraja – S. Chand and Company.
2. Performance and design of AC machines – M.G. Say, ELBS Edn.
3. Mechanical workshop practice, K.C. John, 2010, PHI Learning Pvt. Ltd.
4. Workshop Processes, Practices and Materials, Bruce J Black 2005, 3rd Edn., Editor Newnes [ISBN: 0750660732]
5. New Engineering Technology, Lawrence Smyth/Liam Hennessy, The Educational Company of Ireland [ISBN: 0861674480]

PHYSICS-SEC -2	**BSHP-217-21**	**COMPUTATIONAL PHYSICS**	**L-0, T-1, P-2**	**2 Credits**

Pre-requisite: Understanding of senior secondary level Physics and Mathematics

Course Objectives: *The aim of this course is to*

- *Highlights the use of computational methods to solve physical problems*
- *Course will consist of hands-on training on the Problem solving on Computers.*

Course Outcomes: At the end of the course, the student will be able to

CO1	Introduced the concept of using the computers in Physics.
CO2	analyze practical and theoretical aspects of physics problems with the help of a suitable mathematical model.
CO3	describe and evaluate sources of error for the modeling and calculation for a given problem.
CO4	mathematical modeling and numerical analysis of problems in science and technology.
CO5	how scientific knowledge is achieved by an interplay between theory, modeling and simulation.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	1	3	3	2	3	2	3	3	2
CO2	2	2	1	2	3	3	1	3	1	3	3	2
CO3	3	2	2	2	3	3	2	3	1	3	3	1
CO4	2	2	2	2	3	3	2	3	1	3	3	2
CO5	2	2	2	2	3	3	2	3	1	3	3	2

Detailed Syllabus:

PART-A

UNIT-I

Introduction: Importance of computers in Physics, paradigm for solving physics problems for solution. Operating system, Usage of Linux as an editor, Algorithms and Flowcharts. Concept of flowchart, symbols, guidelines, types. Examples: Cartesian to Spherical Polar Coordinates, Roots of Quadratic Equation, Sum of two matrices, Sum and Product of a finite series, calculation of sin(x) as a series, algorithm for plotting (1) Lissajous figures and (2) trajectory of a projectile thrown at an angle with the horizontal. **(5 Lectures)**

UNIT-II

Scientific Programming using C++/Python: Introduction to the Concept of Object-Oriented Programming; Advantages of C++; Structure of a C++ program, concepts of compiling and linking, IDE and its features; Basic terminology - Character set, tokens, identifiers, keywords, fundamental data types, literal and symbolic constants, declaring variables, initializing variables, type modifiers. Operators in C++, Input/output using extraction and insertion operators, writing simple C++ programs, comments in C++, stages of program execution. **(5 Lectures)**

PART-B

UNIT-III

Control Statements: Types of Logic, Branching Statements, Looping Statements (DO-CONTINUE, DO-ENDDO, DO-WHILE, Implied and Nested DO Loops), Jumping Statements (Unconditional GOTO, Computed GOTO, Assigned GOTO), Subscripted Variables (Arrays: Types of Arrays, DIMENSION Statement, Reading and Writing Arrays), Functions and Subroutines (Arithmetic Statement Function, Function Subprogram and Subroutine), RETURN, CALL, COMMON and EQUIVALENCE Statements), Structure, Disk I/O Statements, open a file, writing in a file, reading from a file. Examples from physics problems. **(5 Lectures)**

UNIT-IV

Programming:

1. Exercises on syntax on usage of C++/Python
2. Usage of GUI Windows, Linux Commands, familiarity with DOS commands and working in an editor to write sources codes in C++/Python.
3. To print out all natural even/ odd numbers between given limits.
4. To find maximum, minimum and range of a given set of numbers.
5. Calculating Euler number using exp(x) series evaluated at x=1.

Reference Books:

1. Introduction to Numerical Analysis, S.S. Sastry, 5th Edn., 2012, PHI Learning Pvt. Ltd.
2. Computer Programming in Fortran 77". V. Rajaraman (Publisher: PHI).
3. Schaum's Outline of Theory and Problems of Programming with Fortran, S Lipsdutz and A Poe, 1986Mc-Graw Hill Book Co.
4. Computational Physics: An Introduction, R. C. Verma et al., New Age International Publishers, New Delhi (1999)
5. A first course in Numerical Methods, U.M. Ascher and C. Greif, 2012, PHI Learning
6. Elementary Numerical Analysis, K.E. Atkinson, 3rd Edn. 2007, Wiley India Edition.

PHYSICS-SEC-3	**BSHP-218-21**	**WEATHER FORECASTING**	**L-0, T-1, P-2**	**2 Credits**

Pre-requisite: Understanding of senior secondary level Physics and Mathematics

Course Objectives: *The aim of this course is not just to impart theoretical knowledge to the students but to enable them to develop an awareness and understanding regarding the causes and effects of different weather phenomenon and basic forecasting techniques.*

Course Outcomes: At the end of the course, the student will be able to

CO1	Students will understand the elements of weather that can be observed, measured, and recorded to make predictions and determine simple weather patterns.
CO2	Observe, measure, and record data on the basic elements of weather over a period of time (i.e., precipitation, air temperature, wind speed and direction, and air pressure).
CO3	Interpret recorded weather data for simple patterns and infer relationships between wind and weather change (e.g., windy days often precede changes in the weather; south winds in Utah often precede a cold front coming from the north).
CO4	Graph the recorded data to show daily and seasonal patterns in weather and evaluate weather predictions based upon observational data.
CO5	provide information to people and organizations can use to reduce weather-related losses and enhance societal benefits, including protection of life and property, public health and safety, and support of economic prosperity and quality of life.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	1	-	1	2	3	2	3	2	3
CO2	2	2	1	2	1	1	1	3	1	3	1	3
CO3	3	2	2	2	1	1	2	3	1	3	1	3
CO4	2	2	2	2	1	1	2	3	1	3	1	3
CO5	2	2	2	2	1	1	2	3	1	3	1	3

Detailed Syllabus:

PART-A

UNIT-I

Introduction to atmosphere: Elementary idea of atmosphere: physical structure and composition; compositional layering of the atmosphere; variation of pressure and temperature with height; air temperature; requirements to measure air temperature; temperature sensors: types; atmospheric pressure: its measurement; cyclones and anticyclones: its characteristics.

(3 Lectures)

UNIT-II

Measuring the weather: Wind; forces acting to produce wind; wind speed direction: units, its direction; measuring wind speed and direction; humidity, clouds and rainfall, radiation: absorption, emission and scattering in atmosphere; radiation laws. Weather systems: Global wind systems; air masses and fronts: classifications; jet streams; local thunderstorms; tropical cyclones: classification; tornadoes; hurricanes.

Climate and Climate Change: Climate: its classification; causes of climate change; global warming and its outcomes; air pollution; aerosols, ozone depletion, acid rain, environmental issues related to climate. **(7 Lectures)**

PART-B

UNIT-III

Basics of weather forecasting: Weather forecasting: analysis and its historical background; need of measuring weather; types of weather forecasting; weather forecasting methods; criteria of choosing weather station; basics of choosing site and exposure; satellites observations in weather forecasting; weather maps; uncertainty and predictability; probability forecasts.

(4 Lectures)

UNIT-IV

Demonstrations and Experiments:

1. Study of synoptic charts & weather reports, working principle of weather station.
2. Processing and analysis of weather data:
   (i) To calculate the sunniest time of the year.
   (ii) To study the variation of rainfall amount and intensity by wind direction.
   (iii) To observe the sunniest/driest day of the week.
   (iv) To examine the maximum and minimum temperature throughout the year.
   (v) To evaluate the relative humidity of the day.
   (vi) To examine the rainfall amount month wise.
3. Exercises in chart reading: Plotting of constant pressure charts, surfaces charts, upper wind charts and its analysis.
4. Formats and elements in different types of weather forecasts/warning (aviation and non-aviation).

Reference books:

1. Aviation Meteorology, I.C. Joshi, 3rd edition 2014, Himalayan Books
2. The weather Observers Handbook, Stephen Burt, 2012, Cambridge University Press.
3. Meteorology, S.R. Ghadekar, 2001, Agromet Publishers, Nagpur.
4. Textbook of Agrometeorology, S.R. Ghadekar, 2005, Agromet Publishers, Nagpur.
5. Why the weather, Charls Franklin Brooks, 1924, Chpraman & Hall, London.
6. Atmosphere and Ocean, John G. Harvey, 1995, The Artemis Press.

SEMESTER-IV

PHYSICS-C-8	**BSHP-221-21**	**MATHEMATICAL PHYSICS-II**	**L-5, T-1, P-0**	**6 Credits**

Pre-requisite: Understanding of senior secondary level Physics and Mathematics

Course Objectives: *The emphasis of the course is on applications in solving problems of interest to physicists. Students are to be examined based on problems, seen and unseen.*

Course Outcomes: At the end of the course, the student will be able to

CO1	Understand how to expand a function in a Fourier series, and under what conditions such an expansion is valid.
CO2	Aware of the connection between Fourier and Laplace transforms and be able to use the latter to solve mathematical problems relevant to the physical sciences.
CO3	Understand Gaussian integrals, integration by parts, differential and integral calculus for many variables, Lagrange multipliers and Jacobins, Taylor series and their applications in physics.
CO4	Understand the implications of Laplace transform
CO5	Understand Fourier analysis of continuous-time signals and systems.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	1	3	2	2	1	2	3	2	3
CO2	2	2	1	2	1	1	1	1	1	3	1	3
CO3	3	2	2	2	1	2	2	1	1	3	1	3
CO4	2	2	2	2	1	2	2	1	1	3	1	3
CO5	2	2	2	2	3	2	2	1	1	3	3	3

Detailed Syllabus:

PART-A

UNIT -I

Fourier Series: Periodic functions. Orthogonality of sine and cosine functions, Dirichlet Conditions (Statement only). Expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients. Complex representation of Fourier series. Expansion of functions with arbitrary period. Expansion of non-periodic functions over an interval. Even and odd functions and their Fourier expansions. **(15 Lectures)**

UNIT -II

Frobenius Method and Special Functions: Singular Points of Second Order Linear Differential Equations and their importance. Frobenius method and its applications to differential equations. Legendre, Bessel Differential Equations, Properties of Legendre Polynomials: Rodrigues Formula, Orthogonality. 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. **(15 Lectures)**

PART-B

UNIT -III

Integrals Transforms: Fourier Transforms: Fourier Integral theorem. Fourier Transform. Examples. Fourier transform of trigonometric, Gaussian, finite wave train & other functions. Representation of Dirac delta function as a Fourier Integral. Fourier transform of derivatives, Inverse Fourier transform, Convolution theorem. Properties of Fourier transforms (translation, change of scale, complex conjugation, etc.). Three dimensional Fourier transforms with examples. Application of Fourier Transforms to differential equations: One dimensional Wave and Diffusion/Heat Flow Equations. **(15 Lectures)**

UNIT -IV

Laplace Transforms: Laplace Transform (LT) of Elementary functions. Properties of LTs: Change of Scale Theorem, Shifting Theorem. LTs of 1^{st} and 2^{nd} order Derivatives and Integrals of Functions, Derivatives, and Integrals of LTs. LT of Unit Step function, Dirac Delta function, Periodic Functions. Convolution Theorem. Inverse LT. Application of Laplace Transforms to 2 order Differential Equations: Damped Harmonic Oscillator, Simple Electrical Circuits, coupled differential equations of 1^{st} order, Solution of heat flow along infinite bar using Laplace transform. **(15 Lectures)**

Reference Books:

1. Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3rd ed. 2006, Cambridge University Press.
2. Mathematics for Physicists, P. Dennery and A.Krzywicki, 1967, Dover Publications
3. Complex Variables, A.S. Fokas & M.J. Ablowitz Ed., 2011, Cambridge Univ. Press
4. Complex Variables, A.K. Kapoor, 2014, Cambridge Univ. Press
5. Complex Variables and Applications, J.W. Brown & R.V. Churchill, 7th Ed. 2003, Tata McGraw-Hill
6. First course in complex analysis with applications, D.G. Zill and P.D. Shanahan, 1940, Jones & Bartlett

PHYSICS-C-9	**BSHP-222-21**	**THERMAL PHYSICS**	**L-3, T-1, P-0**	**4 Credits**

Pre-requisite: Understanding of senior secondary level Physics and Mathematics

Course Objectives: *This course covers laws of thermodynamics and applications, Thermodynamic Potentials, Maxwell's Thermodynamic Relations, Kinetic theory of gases, molecular collisions, and transmission of heat.*

Course Outcomes: At the end of the course, the student will be able to

CO1	Develop a theoretical and experimental approach to give a fundamental understanding of how systems in thermal equilibrium can be described by thermodynamics, kinetical gas theory and basic statistical mechanics.
CO2	Understand the process of thermal conductivity, viscosity and diffusion in gases.
CO3	Ability to evaluate entropy changes in a wide range of processes and determine the reversibility or irreversibility of a process from such calculations.
CO4	Understand the interrelationship between thermodynamic functions and ability to use such relationships to solve practical problems.
CO5	Develop a working knowledge of the Laws and Methods of thermodynamics and to use this knowledge to explore various applications topics in materials science.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	1	-	1	2	1	2	3	2	2
CO2	2	2	1	2	1	1	1	1	1	3	1	1
CO3	3	2	2	2	1	1	2	1	1	3	1	1
CO4	2	2	2	2	1	1	2	1	1	3	1	1
CO5	2	2	2	2	1	1	2	1	1	3	1	1

Detailed Syllabus:

PART-A

UNIT-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: General Relation between CP & CV, Work Done during Isothermal and Adiabatic Processes, Compressibility & Expansion Coefficient, Reversible & irreversible processes, Second law & Entropy, Carnot's cycle & theorem, Entropy changes in reversible & irreversible processes, Entropy-temperature diagrams, Third law of thermodynamics, Un-attainability of absolute zero. **(12 Lectures)**

UNIT-II

Thermodynamic Potentials: Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy. Their Definitions, Properties and Applications. Surface Films and Variation of Surface Tension with Temperature. Magnetic Work, Cooling due to adiabatic demagnetization, First and second order Phase Transitions with examples, Clausius Clapeyron Equation and Ehrenfest equations, Expression for (CP-CV), CP/CV, TdS equations, Extensive and Intensive Thermodynamic Variables. **(10 Lectures)**

PART-B

UNIT-III

Kinetic Theory of Gases: Distribution of Velocities, Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas and its Experimental Verification. Doppler Broadening of Spectral Lines and Stern's Experiment. Mean, RMS and Most Probable Speeds. Degrees of Freedom. Qualitative description of Law of Equipartition of Energy. Specific heats of Gases, Conduction-Coefficient of the thermal conductivity, Lee's disc method to find thermal conductivity of bad conductor.

Molecular Collisions: Mean Free Path. Collision Probability. Estimates of Mean Free Path. Transport Phenomenon in Ideal Gases: (1) Viscosity, (2) Thermal Conductivity and (3) Diffusion. Brownian Motion and its Significance. **(10 Lectures)**

UNIT-IV

Real Gases: Behavior of Real Gases: Deviations from the Ideal Gas Equation. The Virial Equation. Andrew's Experiments on CO2 Gas. Critical Constants. Continuity of Liquid and Gaseous State. Vapour and Gas. Boyle Temperature. Van der Waal's Equation of State for Real Gases. Values of Critical Constants. Law of Corresponding States. Comparison with Experimental Curves. p-V Diagrams. Joule's Experiment. Free Adiabatic Expansion of a Perfect Gas. Joule-Thomson Porous Plug Experiment. Joule- Thomson Effect for Real and Van der Waal Gases. Temperature of Inversion. Joule- Thomson Cooling. **(10 Lectures)**

Reference Books:

1. Statistical Physics, Thermodynamics and Kinetic theory, V.S. Bhatia, 2017, Vishal Publishing Co.
2. Brijlal, N. Subrahmanyam and P. S. Hemne, Heat, Thermodynamics and Statistical Physics, S. Chand, and Company, 2010.
3. Richard H Dittman and Zemansky MW, Heat and Thermodynamics, 3rd Special Edition, McGraw Hill, 2008.
4. Thermal Physics, S. Garg, R. Bansal and C. Ghosh, 1993, Tata McGraw-Hill.
5. A Treatise on Heat, Meghnad Saha, and B.N. Srivastava, 1969, Indian Press.
6. Thermodynamics, Enrico Fermi, 1956, Courier Dover Publications.
7. Thermodynamics, Kinetic theory & Statistical thermodynamics, F.W.Sears & G.L. Salinger,

1988, Narosa.
8. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
9. Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer.
10. Thermal Physics, A. Kumar and S.P. Taneja, 2014, R. Chand Publications.
11. Elements of Thermal Physics, 4th edition, James Wolfe.
12. An Introduction to the Thermal Physics, Daniel V. Schroeder.

PHYSICS-C	**BSHP-223-21**	**PHYSICS LAB-V**	**L-0, T-0, P-4**	**2 Credits**

Pre-requisite: Understanding of senior secondary level Physics and Mathematics

Course Objectives: *The laboratory exercises have been so designed on measurements of thermal conductivity, Temperature Coefficient of Resistance, and use of various temperature transducers.*

Course Outcomes: At the end of the course, the student will be able to

CO1	Able to verify the theoretical concepts/laws learnt in theory courses.
CO2	Trained in carrying out precise measurements and handling sensitive equipment.
CO3	Understand the methods used for estimating and dealing with experimental uncertainties and systematic "errors".
CO4	Learn to draw conclusions from data and develop skills in experimental design.
CO5	Document a technical report which communicates scientific information in a clear and concise manner.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	1	-	1	2	1	2	3	2	2
CO2	2	2	1	2	1	1	1	1	1	3	1	1
CO3	3	2	2	2	1	1	2	1	1	3	1	1
CO4	2	2	2	2	1	1	2	1	1	3	1	1
CO5	2	2	2	2	1	1	2	1	1	3	1	1

Detailed Syllabus:

Note: Students are expected to perform 8-10 experiments from the list taking at least 2-3 from the virtual lab.

1. To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.
2. To measure the coefficient of linear expansion for different metals and alloys.
3. To determine the value of Stefan's Constant of radiation.
4. To determine the Coefficient of Thermal Conductivity of Cu by Searle's Apparatus.
5. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method.
6. To measure the thermal conductivity and thermal diffusivity of a conductor.
7. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton's disc method.
8. To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT).
9. To study the variation of Thermo-Emf of a Thermocouple with Difference of Temperature of its Two Junctions. To calibrate a thermocouple to measure temperature in a specified Range using (i) Null Method, (ii) Direct measurement using Op-Amp difference amplifier and to determine Neutral Temperature.
10. To determine thermal conductivity of a bad conductor disc using Advance kit involving constant current source for heating and thermocouples for temperature measurements.
11. Calibration of Si diode and Copper -Constantan thermocouple as temperature sensor.
12. Measurement of Planck's constant using black body radiation.
13. To determine Stefan's Constant.
14. To determine the coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method.
15. To determine the temperature co-efficient of resistance by Platinum resistance thermometer.
16. To calibrate Resistance Temperature Device (RTD) using Null Method/Off-Balance Bridge.

Reference Books

1. Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House
2. A Textbook of Practical Physics, I. Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
3. Advanced level Physics Practical's, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
4. A Laboratory Manual of Physics for undergraduate classes, D.P. Khandelwal,1985, Vani Pub.

PHYSICS-C-10	**BSHP-224-21**	**DIGITAL ELECTRONICS**	**L-3, T-1, P-0**	**4 Credits**

Pre-requisite: Understanding of basics of electronics.

Course Objectives: *The course covers basics of integrated circuit technology, binary arithmetic, Logic gates, sequential and combinational circuits, Timers and counters, and Computer organization.*

Course Outcomes: At the end of the course, the student will be able to

CO1	Understand the fundamentals of codes and number system
CO2	Understand the binary arithmetic, logics, and Boolean functions.
CO3	Understand the functions and working of flipflop circuits register s and counters.
CO4	Understand the applications into memory circuits.
CO5	Understand synchronous sequential circuits, registers and multiplexer-demultiplexer.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	1	-	1	2	1	2	3	2	2
CO2	2	2	1	2	1	1	1	1	1	3	1	1
CO3	3	2	2	2	1	1	2	1	1	3	1	1
CO4	2	2	2	2	1	1	2	1	1	3	1	1
CO5	2	2	2	2	1	1	2	1	1	3	1	1

Detailed Syllabus:

PART-A

UNIT-I

Digital Circuits: Binary Numbers. Decimal to Binary and Binary to Decimal Conversion. BCD, Octal and Hexadecimal numbers. AND, OR and NOT Gates (realization using Diodes and Transistor). NAND and NOR Gates as Universal Gates. XOR and XNOR Gates and application as Parity Checkers. Boolean algebra: De Morgan's Theorems. Boolean Laws. Simplification of Logic Circuit using Boolean Algebra. Fundamental Products. Idea of Minterms and Maxterms. Conversion of a Truth table into Equivalent Logic Circuit by (1) Sum of Products Method and (2) Karnaugh Map. **(11 Lectures)**

UNIT-II

Data Processing Circuits: Basic idea of Multiplexers, De-multiplexers, Decoders, Encoders. Arithmetic Circuits: Binary Addition. Binary Subtraction using 2's Complement. Half and Full Adders. Half & Full Subtractors, 4-bit binary Adder/Subtractor. **(9 Lectures)**

PART-B

UNIT-III

Sequential Circuits: SR, D, and JK Flip-Flops. Clocked (Level and Edge Triggered) Flip-Flops. Preset and Clear operations. Race-around conditions in JK Flip-Flop. M/S JK Flip-Flop. Timers: IC 555: block diagram and applications: Astable multivibrator and Monostable multivibrator. Shift registers: Serial-in-Serial-out, Serial-in-Parallel-out, Parallel-in-Serial-out and Parallel-in-Parallel-out Shift Registers (only up to 4 bits). **(10 Lectures)**

UNIT-IV

Counters and Converters: Counters (4 bits): Ring Counter. Asynchronous counters, Decade Counter. Synchronous Counter. Computer Organization: Input/Output Devices. Data storage (idea of RAM and ROM). Computer memory. Memory organization & addressing. Digital to analogue converter, analogue to digital converter using counter. **(10 Lectures)**

Reference Books:

1. Digital Principles and Applications, A.P. Malvino, D.P.Leach and Saha, 7th Ed., 2011,Tata McGraw

2. Fundamentals of Digital Circuits, Anand Kumar, Edn, 2009, PHI Learning Pvt. Ltd.

3. Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.

4. Digital Electronics G K Kharate ,2010, Oxford University Press

5. Digital Systems: Principles & Applications, R.J.Tocci, N.S. Widmer, 2001, PHI Learning

6. Logic circuit design, Shimon P. Vingron, 2012, Springer.

7. Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.

8. Digital Electronics, S.K. Mandal, 2010, edition, McGraw Hill

PHYSICS-C	**BSHP-225-21**	**PHYSICS LAB-VI**	**L-0, T-0, P-4**	**2 Credits**

Pre-requisite: Understanding of senior secondary level Physics and Mathematics

Course Objectives: *The laboratory exercises have been so designed that the students learn to verify some of the concepts learnt in the theory course of digital electronics. It covers practical training on basic Logic gates, flip-flops, sequential and combinational circuits, Timers, and counters.*

Course Outcomes: At the end of the course, the student will be able to

CO1	Able to verify the theoretical concepts/laws learnt in theory courses.
CO2	Trained in carrying out precise measurements and handling sensitive equipment.
CO3	Understand the methods used for estimating and dealing with experimental uncertainties and systematic "errors".
CO4	Learn to draw conclusions from data and develop skills in experimental design.
CO5	Document a technical report which communicates scientific information in a clear and concise manner.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	1	-	1	2	1	2	3	2	2
CO2	2	2	1	2	1	1	1	1	1	3	2	1
CO3	3	2	2	2	2	1	2	1	1	3	2	1
CO4	2	2	2	2	1	1	2	1	1	3	2	1
CO5	2	2	2	2	1	1	2	1	1	3	2	1

Detailed Syllabus:

Note: Students are expected to perform 8-10 experiments from the list taking at least 2-3 from the virtual lab.

List of Experiments:

1. To measure (a) Voltage, and (b) Time period of a periodic waveform using CRO.
2. To test a Diode and Transistor using a Multimeter.
3. To design a switch (NOT gate) using a transistor.
4. To verify and design AND, OR, NOT and XOR gates using NAND gates.
5. To design a combinational logic system for a specified Truth Table.
6. To convert a Boolean expression into logic circuit and design it is using logic gate ICs.
7. To minimize a given logic circuit.
8. Half Adder, Full Adder, and 4-bit binary Adder.
9. Half Subtractor, Full Subtractor, Adder-Subtractor using Full Adder I.C.
10. To build Flip-Flop (RS, Clocked RS, D-type and JK) circuits using NAND gates.
11. To build JK Master-slave flip-flop using Flip-Flop ICs
12. To build a 4-bit Counter using D-type/JK Flip-Flop ICs and study timing diagram.
13. To make a 4-bit Shift Register (serial and parallel) using D-type/JK Flip-Flop ICs.
14. To design an astable multivibrator of given specifications using 555 Timer.
15. To design a monostable multivibrator of given specifications using 555 Timer.

Reference Books:

1. Modern Digital Electronics, R.P. Jain, 4th Edition, 2010, Tata McGraw Hill.
2. Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw Hill.

General Elective (GE)-6 Mathematics	**BSHM-408-21**	**Matrices & Ordinary Differential Equations**	**L-4, T-1, P-0**	**4 Credits**

Pre-requisite: Students must have the knowledge of basic algebraic operations, differentiation, and integration.

Course Objectives: The objective of the course on **Matrices & Ordinary Differential Equations** is to equip the B.Sc. (Hons) students with the theoretical aspects of matrices. Their applications in system of equations and real-life engineering problems. Furthermore, students will be introduced to Ordinary Differential Equations.

Course Outcomes: At the end of the course, the student will be able to

CO1	Learn the basic concepts of Matrices.
CO2	Understand about operations on matrices, such as, addition, subtraction and multiplication and concept of determinants.
CO3	Use matrices in solving system of equations using Gauss Elimination method, Gauss-Jordon method, Matrix inversion method etc.
CO4	Be acquainted with knowledge of ordinary differential equations and Linear differential equations.
CO5	Apply the learnt techniques in solving various problems related to differential equations.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	1	-	1	2	1	2	3	2	2
CO2	2	2	1	2	1	1	1	1	1	3	2	1
CO3	3	2	2	2	2	1	2	1	1	3	2	1
CO4	2	2	2	2	1	1	2	1	1	3	2	1
CO5	2	2	2	2	1	1	2	1	1	3	2	1

Detailed Syllabus:

PART A

UNIT-I

Matrices: Introduction to matrix, Different kinds of matrices, Addition, Multiplication, Symmetric and Skew symmetric matrix, Transpose of matrix, trace of a matrix.
Determinants: Determinant of matrix, Properties of determinant, Singular and non-singular matrices, Adjoint and inverse of a matrix, Rank of a matrix.

UNIT-II

Linear System of Equations: Introduction to system of linear equations, Condition of Consistency of system of linear equations, Homogenous and Non-homogenous system of equations, Echelon form. Solving Linear system of Equations: Matrix inversion method, Gauss-Jordon method and Gauss Elimination method.

PART B

UNIT-III

ODE: Introduction of differential coefficient, Ordinary differential equation, Order and degree of differential equation, Formation of differential equation, Difference between linear and non-linear differential equations.

UNIT-IV

Solving Ordinary Differential Equations: Solution of Separable differential equations, linear differential equations of the first order, Exact differential equations, Solution of homogeneous differential equations, Bernoulli's equation and Riccati equation, The chemical application of these first order differential equations.

Text and Reference Books:

1. Mathematics 10+2, NCERT, New Delhi.
2. Kreyszig, E., *Advanced Engineering Mathematics*, 9th Edition Wiley Publications, 2005.
3. O'Neil, P.V., *Advanced Engineering Mathematics 7th Edition,* Cengage Learning Custom Publishing, 2011.
4. Jain, R.K. and Iyengar, S.K., *Advanced Engineering Mathematics 5th Edition.* New Delhi: Narosa Publication, 2011.

Ability Enhancement Course (AEC)-5	**EVS-101A**	**Environmental Studies**	**L-2, T-0, P-0**	**2 Credits**

Pre-requisites (if any): NA

Course Objectives: The aim and objective of this course is to teach the fundamental concepts of Environment as a whole along with Natural Resources, their types, and issues related with sustainable use as its components along with social issues related with environment.

Course Outcomes: At the end of the course, the student will be

CO1	Understand the fundamental concepts about Environment and its components.
CO2	Know about various types of natural resources, their functions, uses, exploitation and the problems arise due to these along with suitable case studies.
CO3	Gain knowledge about working of various ecosystems, their features and functions and energy flow through them.
CO4	Know about biodiversity, its various forms, importance and significant areas

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	1	2	1	2	2	2	3	2	2
CO2	2	2	1	2	2	1	1	2	2	3	2	2
CO3	3	2	2	2	2	1	2	2	1	3	2	2
CO4	2	2	2	2	1	1	2	2	1	3	2	1
CO5	2	2	2	2	1	1	2	1	1	3	2	1

Detailed Syllabus:

PART-A

UNIT-I

Multidisciplinary nature of environmental studies, Definition, scope and importance, Need for public awareness. **(3 Lectures)**

UNIT-II

Natural Resources: Renewable and non-renewable resources: Natural resources and associated problems.

a) Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people.

b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems.

c) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies.

d) Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.

e) Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of

alternate energy sources. Case studies.

f) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification.
• Role of an individual in conservation of natural resources.
• Equitable use of resources for sustainable lifestyles. **(10 Lectures)**

PART-B

UNIT-III

Ecosystems
• Concept of an ecosystem.
• Structure and function of an ecosystem.
• Producers, consumers and decomposers.
• Energy flow in the ecosystem.
• Ecological succession.
• Food chains, food webs and ecological pyramids.
• Introduction, types, characteristic features, structure, and function of the following ecosystem: -
a. Forest ecosystem
b. Grassland ecosystem
c. Desert ecosystem
d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries). **(8 Lectures)**

UNIT-IV

Biodiversity and its conservation
• Introduction – Definition: genetic, species and ecosystem diversity.
• Biogeographical classification of India
• Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values
• Biodiversity at global, National, and local levels.
• India as a mega-diversity nation
• Hot spots of biodiversity.
• Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts.
• Endangered and endemic species of India
• Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity. **(6 Lectures)**

RECOMMENDED BOOKS

1. K.C. Aggarwal, Environmental Biology, Nidi Publishers, 2001
2. E.P. Odum, Fundamentals of Ecology, WB Saunders, 1971
3. Erach Bharucha, The Biodiversity of India, Mapin Publishers, 2003
4. Benny Joseph, Environmental Studies, McGraw Hills, 2015.
5. R Rajagopalan, Environmental Studies, Oxford Higher Education, 2016.
6. S.P. Misra & S.N. Pandey, Essential Environmental Studies, Ane Books Pvt. Ltd. 2016.

PHYSICS-SEC -4	**BSHP-226-21**	**ELECTRICAL CIRCUITS AND NETWORK SKILLS**	**L-0, T-1, P-2**	**2 Credits**

Pre-requisite: Understanding of senior secondary level Physics and Mathematics

Course Objectives: *The aim of this course is to enable the students to design, and trouble-shoot the electrical circuits, networks, and appliances through hands-on mode.*

Course Outcomes: At the end of the course, the student will be able to

CO1	Familiarization with basic electronics devices such as, multimeter, voltmeter, and ammeter.
CO2	Understand the concept of generators and transformers.
CO3	Understand the DC Power sources, AC/DC generators, inductance, capacitance, and impedance.
CO4	Apply the concept of operation of transformers.
CO5	Understand the concept of electric wiring and usage.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	1	-	1	2	2	2	3	2	2
CO2	2	2	1	2	1	1	1	1	1	3	1	1
CO3	3	2	2	2	1	1	2	2	1	3	1	2
CO4	2	2	2	2	1	1	2	2	1	3	1	2
CO5	2	2	2	2	1	1	2	2	1	3	1	2

Detailed Syllabus:

PART-A

UNIT I

Basic Electricity Principles: Voltage, Current, Resistance, and Power. Ohm's law. Series, parallel, and series-parallel combinations. AC Electricity and DC Electricity. Familiarization with multimeter, voltmeter, and ammeter.

Understanding Electrical Circuits: Main electric circuit elements and their combination. Rules to analyze DC sourced electrical circuits. Current and voltage drop across the DC circuit elements. Single-phase and three-phase alternating current sources. Rules to analyze AC sourced electrical circuits. Real, imaginary, and complex power components of AC source. Power factor. Saving energy and money. **(6 Lectures)**

UNIT -II

Generators and Transformers: DC Power sources. AC/DC generators. Inductance, capacitance, and impedance. Operation of transformers.

Electric Motors: Single-phase, three-phase & DC motors. Basic design. Interfacing DC or AC sources to control heaters & motors. Speed & power of ac motor. **(5 Lectures)**

PART-B

UNIT-III

Solid-State Devices: Resistors, inductors, and capacitors. Diode and rectifiers. Components in Series or in shunt. Response of inductors and capacitors with DC or AC sources.

Electrical Protection: Relays. Fuses and disconnect switches. Circuit breakers. Overload devices. Ground-fault protection. Grounding and isolating. Phase reversal. Surge protection. Interfacing DC or AC sources to control elements (relay protection device) **(6 Lectures)**

UNIT-IV

Electrical Wiring: Different types of conductors and cables. Basics of wiring-Star and delta connection. Voltage drops and losses across cables and conductors. Instruments to measure current, voltage, power in DC and AC circuits. Insulation. Solid and stranded cable. Conduit. Cable trays. Splices: wirenuts, crimps, terminal blocks, split bolts, and solder. Preparation of extension board. **(5 Lectures)**

Reference Books:

1. A textbook in Electrical Technology - B L Theraja and A K Theraja - S Chand & Co.
2. Performance and design of AC machines - M G Say, CBS Publisher.
3. Electronic Principles (SIE)- Albert Malvino and David J. Bates 7th Edition, McGraw Hill Education.

PHYSICS-SEC - 5	**BSHP-227-21**	**BASIC INSTRUMENTATION SKILLS**	**L-0, T-1, P-2**	**2 Credits**

Pre-requisite: Understanding of senior secondary level Physics and Mathematics

Course Objectives: *This course is to get exposure with various aspects of instruments and their usage through hands-on mode. Experiments listed below are to be done in continuation of the topics.*

Course Outcomes: At the end of the course, the student will be able to

CO1	Apply the fundamentals of instrumentation in measurements and calibration of instruments.
CO2	Make use of instrument with appropriate specifications and design of extension of range instrument.
CO3	Experiment with different bridge circuits for unknown parameter (Resistance, Capacitance) measurement.
CO4	Demonstrate the use of oscilloscopes for electrical parameter measurement.
CO5	Select the digital instrument for the measurement of given parameter and make use of recorder and function generator for the specified parameter

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	1	2	1	2	2	2	3	2	2
CO2	2	2	1	2	1	1	1	1	1	3	1	1
CO3	3	2	2	2	2	1	2	2	1	3	1	2
CO4	2	2	2	2	2	1	2	2	1	3	1	2
CO5	2	2	2	2	2	1	2	2	1	3	1	2

Detailed Syllabus:

PART-A

UNIT-I

Basic of Measurement: Instruments accuracy, precision, sensitivity, resolution range etc. Errors in measurements and loading effects. Multimeter: Principles of measurement of dc voltage and dc current, ac voltage, ac current and resistance. Specifications of a multimeter and their significance.

Electronic Voltmeter: Advantage over conventional multimeter for voltage measurement with respect to input impedance and sensitivity. Principles of voltage, measurement (block diagram only). Specifications of an electronic Voltmeter/ Multimeter and their significance. AC millivoltmeter: Type of AC millivoltmeters: Amplifier- rectifier, and rectifier- amplifier. Block diagram ac millivoltmeter, specifications and their significance. **(6 Lectures)**

UNIT-II

Cathode Ray Oscilloscope: Block diagram of basic CRO. Construction of CRT, Electron gun, electrostatic focusing and acceleration (Explanation only-no mathematical treatment), brief discussion on screen phosphor, visual persistence & chemical composition. Time base operation, synchronization. Front panel controls. Specifications of a CRO and their significance.

Use of CRO for the measurement of voltage (dc and ac frequency, time-period, Special features of dual trace, introduction to digital oscilloscope, probes. Digital storage Oscilloscope: Block diagram and principle of working. **(6 Lectures)**

PART B

UNIT-III

Signal Generators and Analysis Instruments: Block diagram, explanation, and specifications of low frequency signal generators. pulse generator, and function generator. Brief idea for testing, specifications. Distortion factor meter, wave analysis.

Impedance Bridges & Q-Meters: Block diagram of bridge. working principles of basic (balancing type) RLC bridge. Specifications of RLC bridge. Block diagram & working principles of a Q- Meter. Digital LCR bridges. **(6 Lectures)**

UNIT-IV

Digital Instruments: Principle and working of digital meters. Comparison of analog & digital instruments. Characteristics of a digital meter. Working principles of digital voltmeter.

Digital Multimeter: Block diagram and working of a digital multimeter. Working principle of time interval, frequency and period measurement using universal counter/ frequency counter, time-base stability, accuracy, and resolution. **(5 Lectures)**

The test of lab skills will be of the following test items:

1. Use of an oscilloscope.
2. CRO as a versatile measuring device.
3. Circuit tracing of Laboratory electronic equipment,
4. Use of Digital multimeter/VTVM for measuring voltages
5. Circuit tracing of Laboratory electronic equipment
6. Winding a coil / transformer
7. Study the layout of receiver circuit.
8. Trouble shooting a circuit
9. Balancing of bridges

Laboratory Exercises:

1. To observe the loading effect of a multimeter while measuring voltage across a low resistance and high resistance.
2. To observe the limitations of a multimeter for measuring high frequency voltage and currents.
3. To measure Q of a coil and its dependence on frequency, using a Q-meter.
4. Measurement of voltage, frequency, time period and phase angle using CRO.
5. Measurement of time period, frequency, average period using universal counter/ frequency counter.
6. Measurement of rise, fall and delay times using a CRO.
7. Measurement of distortion of a RF signal generator using distortion factor meter.
8. Measurement of R, L and C using a LCR bridge/ universal bridge.
9. Using a Dual Trace Oscilloscope
10. Converting the range of a given measuring instrument (voltmeter, ammeter)

Reference Books:

1. A Textbook in Electrical Technology - B L Theraja - S Chand and Co.
2. Performance and design of AC machines - M G Say ELBS Edn.
3. Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
4. Logic circuit design, Shimon P. Vingron, 2012, Springer.
5. Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.
6. Electronic Devices and circuits, S. Salivahanan & N. S.Kumar, Ed., 2012, Tata Mc Graw Hill.
7. Electronic circuits: Handbook of design and applications, U.Tietze, Ch.Schenk, 2008, Springer
8. Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India

PHYSICS-SEC - 6	**BSHP-228-21**	**SCIENTIFIC WORD PROCESSING**	**L-0, T-1, P-2**	**2 Credits**

Pre-requisite: Understanding of senior secondary level Physics and Mathematics

Course Objectives: *The aim of this course is not just to teach scientific documentation methods and numerical analysis but to emphasize its role in solving problems in Physics.*

- *Use of latex as a tool in writing scientific document in physics applications.*
- *Course will consist of hands-on training on the latex on Computers.*

Course Outcomes: At the end of the course, the student will be able to

CO1	Explain, install, and use of TeX and LaTeX.
CO2	Describes the development process of TeX and LaTeX.
CO3	Explains the difference between TeX and LaTeX.
CO4	Tells the advantages of LaTeX over other more traditional software's.
CO5	Lists LaTeX compatible operating systems and use latex for scientific documentation purpose.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	1	2	2	2	1	2	3	2	2
CO2	2	2	1	2	1	1	1	1	1	3	1	1
CO3	3	2	2	2	2	2	2	1	1	3	1	2
CO4	2	2	2	2	2	2	2	1	1	3	1	2
CO5	2	2	2	2	1	1	2	1	1	3	1	2

Detailed Syllabus:

PART-A

UNIT-I

Introduction to LaTeX: TeX/LaTeX word processor, preparing a basic LaTeX file, Document classes, preparing an input file for LaTeX, Compiling LaTeX File, LaTeX tags for creating different environments, Defining LaTeX commands and environments, Changing the type of style, Symbols from other languages. **(6 Lectures)**

UNIT-II

Equation representation: Formulae and equations, Figures and other floating bodies, lining in columns- Tabbing and tabular environment, generating table of contents, bibliography, and citation, making an index and glossary, List making environments, Fonts, Picture environment and colors, errors. **(8 Lectures)**

PART-B

UNIT-III

Visualization: Introduction to graphical analysis and its limitations. Introduction to Gnuplot importance of visualization of computational and computational data, basic Gnuplot commands: simple plots, plotting data from a file, saving, and exporting, multiple data sets per file, physics with Gnuplot (equations, building functions, user defined variables and functions), Understanding data with Gnuplot. **(8 Lectures)**

UNIT-IV

Exercises:

1. Write a 20 pages report in latex on any topic of your interest in Physics.
2. Creating an input Gnuplot file for plotting a data and saving the output for seeing on the screen. Saving it as an .eps file and as a .pdf file.

Reference Books:

1. LaTeX-A Document Preparation System", Leslie Lamport (Second Edition, Addison- Wesley, 1994).
2. Gnuplot in action: understanding data with graphs, Philip K Janert, (Manning 2010)
3. Schaum's Outline of Theory and Problems of Programming with Fortran, S Lipsdutz and A Poe, 1986Mc-Graw Hill Book Co.
4. Computational Physics: An Introduction, R. C. Verma et al. New Age International Publishers, New Delhi (1999).

SEMESTER-V

PHYSICS-C-11	**BSHP-311-21**	**QUANTUM MECHANICS**	**L-5, T-1, P-0**	**6 Credits**

Pre-requisite: Understanding of senior secondary level Physics and Mathematics

Course Objectives: *The aim of course includes examples to explain the quantization of energy, superposition principle, wave-particle duality, tunnelling and quantum theory of hydrogen atom, atoms in electric and magnetic field.*

Course Outcomes: At the end of the course, the student will be able to

CO1	Understand and explain the differences between classical and quantum mechanics and origins of quantum mechanics
CO2	Understand the idea of wave functions, probability and uncertainty relations
CO3	Understand the Schrodinger wave mechanics and operator formalism
CO4	Solve the Schrodinger equation for simple 1D time-independent potentials
CO5	Identify and relate the eigenvalue problems for energy, momentum, angular momentum, and central potentials

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	1	-	1	2	1	2	3	2	2
CO2	2	2	1	2	1	1	1	1	1	3	1	1
CO3	3	2	2	2	1	1	2	1	1	3	1	1
CO4	2	2	2	2	1	1	2	1	1	3	1	1
CO5	2	2	2	2	1	1	2	1	1	3	1	1

Detailed Syllabus:

PART-A

UNIT-I

Time dependent Schrodinger wave equation: Time dependent Schrodinger equation and dynamical evolution of a quantum state; Properties of Wave Function. Interpretation of Wave Function Probability and probability current densities in three dimensions; Conditions for Physical Acceptability of Wave Functions. Normalization. Linearity and Superposition Principles. Eigenvalues and Eigenfunctions. Position, momentum, and Energy operators; commutator of position and momentum operators; Expectation values of position and momentum. Wave Function of a Free Particle. **(15 Lectures)**

UNIT-II

Time independent Schrodinger wave equation-Hamiltonian, stationary states, and energy eigenvalues; expansion of an arbitrary wavefunction as a linear combination of energy eigenfunctions; General solution of the time dependent Schrodinger equation in terms of linear combinations of stationary states; Application to spread of Gaussian wave-packet for a free particle in one dimension; wave packets, Fourier transforms and momentum space wavefunction; Position-momentum uncertainty principle.

General discussion of bound states in an arbitrary potential: Application to one-dimensional problem-square well potential; simple harmonic oscillator-energy levels and energy eigenfunctions using Frobenius method; Hermite polynomials; ground state, zero-point energy & uncertainty principle**.** **(15 Lectures)**

PART-B

UNIT-III

Quantum theory of hydrogen-like atoms: time independent Schrodinger equation in spherical polar coordinates; separation of variables for second order partial differential equation; angular momentum operator & quantum numbers; Radial wavefunctions from Frobenius method; shapes of the probability densities for ground & first excited states; Orbital angular momentum quantum numbers l and m; s, p, d, ... shells.

Atoms in Electric & Magnetic Fields: Electron angular momentum. Space quantization. Electron Spin and Spin Angular Momentum. Larmor's Theorem. Spin Magnetic Moment. Stern-Gerlach Experiment. Zeeman Effect: Electron Magnetic Moment and Magnetic Energy, Gyromagnetic Ratio and Bohr Magneton. **(15 Lectures)**

UNIT-IV

Atoms in External Magnetic Fields: Normal and Anomalous Zeeman Effect. Paschen Back and Stark Effect (Qualitative Discussion only).

Many electron atoms: Pauli's Exclusion Principle. Symmetric & Antisymmetric Wave Functions. Periodic table. Fine structure. Spin orbit coupling. Spectral Notations for Atomic States. Total angular momentum. Vector Model. Spin-orbit coupling in atoms: L-S and J-J couplings. Hund's Rule. Spectra of Hydrogen and Alkali Atoms (Na etc.). **(15 Lectures)**

Reference Books:

1. A Textbook of Quantum Mechanics, P.M. Mathews and Venkatesan, 2nd Ed. 2010, McGraw Hill
2. Quantum Mechanics, Robert Eisberg and Robert Resnick, 2nd Edn., 2002, Wiley.
3. Quantum Mechanics, Leonard I. Schiff, 3rd Edn. 2010, Tata McGraw Hill.
4. Quantum Mechanics, G. Aruldhas, 2nd Edn. 2002, PHI Learning of India.
5. Quantum Mechanics, Bruce Cameron Reed, 2008, Jones and Bartlett Learning.
6. Quantum Mechanics: Foundations & Applications, Arno Bohm, 3rd Edn., 1993, Springer
7. Quantum Mechanics for Scientists & Engineers, D.A.B. Miller, 2008, Cambridge University Press
8. Quantum Mechanics, Eugen Merzbacher, 2004, John Wiley and Sons, Inc.
9. Introduction to Quantum Mechanics, D.J. Griffith, 2nd Ed. 2005, Pearson Education

10. Quantum Mechanics, Walter Greiner, 4th Edn., 2001, Springer.

PHYSICS-C-12	**BSHP-312-21**	**SOLID STATE PHYSICS**	**L-3, T-1, P-0**	**4 Credits**

Pre-requisite: Understanding of senior secondary level Physics and Mathematics

Course Objectives*: The course introduces solid state physics and will enable the student to employ classical and quantum mechanical theories needed to understand the physical properties of solids. Emphasis is put on building models able to explain several different phenomena in the solid state.*

Course Outcomes: At the end of the course, the student will be able to

CO1	Understand free electron Fermi gas: density of states, Fermi level, and electrical conductivity
CO2	Understand electrons in periodic potential: energy bands theory classification of metals, semiconductors and insulators
CO3	Understand semiconductors: band gap, effective masses, charge carrier distributions, doping, p-n junctions
CO4	Understand metals: Fermi surfaces, temperature dependence of electrical conductivity
CO5	Understand the relationship between conductors and insulators and super conductivity

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	1	1	2	2	2	2	3	2	2
CO2	2	2	1	2	1	1	1	1	1	3	1	1
CO3	3	2	2	2	1	2	2	2	1	3	2	1
CO4	2	2	2	2	1	2	2	2	1	3	2	2
CO5	2	2	2	2	1	2	2	2	1	3	2	1

Detailed Syllabus:

PART-A

UNIT-I

Crystal Structure: Solids: Amorphous and Crystalline Materials. Lattice Translation Vectors. Lattice with a Basis – Central and Non-Central Elements. Unit Cell. Miller Indices. Reciprocal Lattice. Types of Lattices. Brillouin Zones. Diffraction of X-rays by Crystals. Bragg's Law. Atomic and Geometrical Factor.

Lattice Dynamics: Lattice Vibrations and Phonons: Linear Monoatomic and Diatomic Chains. Acoustical and Optical Phonons. Qualitative Description of the Phonon Spectrum in Solids. Dulong and Petit's Law, Einstein and Debye's theories of specific heat of solids. T3/2 law. **(15 Lecturers)**

Unit-II

Elementary Band theory: Nearly Free electron model, Density of states, Bloch Theorem, the wavefunction of an electron in a periodic potential, Origin of Band Gap, Kronig Penny model, Tight binding method, Semiconductor crystals (P and N type), Effective mass, Conductivity of Semiconductor, mobility, Hall Effect, Measurement of conductivity using four probe method & Hall coefficient. **(12 Lectures)**

PART-B

UNIT-III

Magnetic Properties of Matter: Dia-, Para-, Ferri- and Ferromagnetic Materials. Classical Langevin Theory of dia- and Paramagnetic Domains. Quantum Mechanical Treatment of Para-magnetism. Curie's law, Weiss's Theory of Ferromagnetism and Ferromagnetic Domains. Discussion of B-H Curve. Hysteresis and Energy Loss.

Ferroelectric Properties of Materials: Structural phase transition, Classification of crystals, Piezoelectric effect, Pyroelectric effect, Ferroelectric effect, Electrostrictive effect, Curie-Weiss Law, Ferroelectric domains, PE hysteresis loop. **(15 Lectures)**

UNIT-IV

Dielectric Properties of Materials: Polarization. Local Electric Field at an Atom. Depolarization Field. Electric Susceptibility. Polarizability. Clausius Mosotti Equation. Classical Theory of Electric Polarizability. Normal and Anomalous Dispersion.

Superconductivity: Experimental Results. Critical Temperature. Critical magnetic field. Meissner effect. Type I and type II Superconductors, London's Equation and Penetration Depth. Isotope effect, Idea of BCS theory (No derivation) **(15 Lectures)**

Reference Books:

1. Introduction to Solid State Physics, Charles Kittel, 8th Edition, 2004, Wiley India Pvt. Ltd.
2. Elements of Solid State Physics, J.P. Srivastava, 2nd Edition, 2006, Prentice-Hall of India
3. Introduction to Solids, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill
4. Solid State Physics, N.W. Ashcroft and N.D. Mermin, 1976, Cengage Learning
5. Solid-state Physics, H. Ibach and H. Luth, 2009, Springer
6. Elementary Solid State Physics, 1/e M. Ali Omar, 1999, Pearson India

7. Solid State Physics, M.A. Wahab, 2011, Narosa Publications

PHYSICS-C	**BSHP-313-21**	**PHYSICS LAB-VII**	**L-0, T-0, P-4**	**2 Credits**

Pre-requisite: Understanding of senior secondary level Physics and Mathematics

Course Objectives: The aim and objective of the lab course is to introduce the students to the formal structure of solid state physics so that they can use these as per their requirement.

Course Outcomes: At the end of the course, the student will be able to

CO1	Able to verify the theoretical concepts/laws learnt in theory courses.
CO2	Trained in carrying out precise measurements and handling sensitive equipment.
CO3	Understand the methods used for estimating and dealing with experimental uncertainties and systematic "errors".
CO4	Learn to draw conclusions from data and develop skills in experimental design.
CO5	Document a technical report which communicates scientific information in a clear and concise manner.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	1	2	2	2	2	2	3	2	2
CO2	2	2	1	2	3	1	1	1	2	3	1	1
CO3	3	2	2	2	2	2	2	2	2	3	2	2
CO4	2	2	2	2	2	2	2	2	1	3	2	2
CO5	2	2	2	2	2	2	2	2	1	3	2	2

Detailed Syllabus:

Note: Students are expected to perform 8-10 experiments from the list taking at least 2-3 from the virtual lab.

List of Experiments:

1. Measurement of susceptibility of paramagnetic solution (Quinck's Tube Method)
2. To measure the Magnetic susceptibility of Solids.
3. To determine the Coupling Coefficient of a Piezoelectric crystal.
4. To measure the Dielectric Constant of a dielectric Materials with frequency
5. To determine the complex dielectric constant and plasma frequency of metal using Surface Plasmon resonance (SPR)
6. To determine the refractive index of a dielectric layer using SPR
7. To study the PE Hysteresis loop of a Ferroelectric Crystal.
8. To draw the BH curve of Fe using Solenoid & determine energy loss from Hysteresis.
9. To measure the resistivity of a semiconductor (Ge) with temperature by four-probe method (room temperature to 150 oC) and to determine its band gap.
10. To determine the Hall coefficient of a semiconductor sample.
11. Study of Electron spin resonance- determine magnetic field as a function of the resonance frequency
12. To study of Zeeman effect: with external magnetic field; Hyperfine splitting
13. To show the tunneling effect in tunnel diode using I-V characteristics.
14. Quantum efficiency of CCDs

Reference Books

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practicals, Michael Nelson, and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
3. A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
4. Elements of Solid-State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice-Hall of India.

PHYSICS-C	**BSHP-314-21**	**COMPUTATIONAL PHYSICS LAB**	**L-0, T-0, P-4**	**2 Credits**

Pre-requisite: Understanding of senior secondary level Physics and Mathematics

Course Objectives: The aim and objective of the lab course is to introduce the students to the formal structure of computational physics so that they can use these essential to solve the physics problems.

Course Outcomes: At the end of the course, the student will be able to

CO1	Able to verify the theoretical concepts/laws learnt in theory courses.
CO2	Trained in carrying out precise measurements and handling sensitive equipment.
CO3	Understand the methods used for estimating and dealing with experimental uncertainties and systematic "errors".
CO4	Learn to draw conclusions from data and develop skills in experimental design.
CO5	Document a technical report which communicates scientific information in a clear and concise manner.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	1	-	1	2	1	2	3	2	2
CO2	2	2	1	2	1	1	1	1	1	3	1	2
CO3	3	2	2	2	1	1	2	1	1	3	1	1
CO4	2	2	2	2	1	1	2	1	1	3	1	1
CO5	2	2	2	2	1	1	2	1	1	3	2	2

Note: Students are expected to perform atleast 10 experiments out of following list using C++ and Gnuplot.

List of experiments:

1. To find the standard deviation, mean, variance, moments etc. of at least 15 entries.
2. To compile a frequency distribution and evaluate mean, standard deviation etc.
3. To evaluate sum of finite series and the area under a curve.
4. To find the product of two matrices
5. To find a set of prime numbers and Fibonacci series.
6. To write program to open a file and generate data for plotting using Gnuplot.
7. To choose a set of 10 values and find the least squared fitted curve.
8. Plotting trajectory of a projectile projected horizontally.
9. Plotting trajectory of a projectile projected making an angle with the horizontally.
10. To find the roots of a quadratic equation.
11. Motion of a projectile using simulation and plot the output for visualization.
12. Numerical solution of equation of motion of simple harmonic oscillator and plot the outputs for visualization.
13. Motion of particle in a central force field and plot the output for visualization.
14. To find the determinant of a matrix and its eigenvalues and eigenvectors.
15. To generate random numbers between (i) 1 and 0, (ii) 1 and 100.

Text and Reference Books:

1. Numerical Mathematical Analysis, J.B. Scarborough (Oxford & IBH Book Co.) 6th ed., 1979.
2. A first course in Computational Physics: P.L. DeVries (Wiley) 2nd edition, 2011.
3. Computer Applications in Physics: S. Chandra (Narosa) 2nd edition, 2005.
4. Computational Physics: R.C. Verma, P.K. Ahluwalia and K.C. Sharma (New Age) 2000.
5. Object Oriented Programming with C++: Balagurusamy, (Tata McGrawHill) 4th edition 2008.

PHYSICS-DSE -1	**BSHP-315-21**	**ATOMIC AND MOLECULAR PHYSICS**	**L-5, T-1, P-0**	**6 Credits**

Pre-requisite: Understanding of senior secondary level Physics and Mathematics

Course Objectives: *The course contents cover the basics of atomic structure, hydrogen, and alkali spectra, coupling schemes, molecular electronic spectra, Infrared and Raman spectroscopy.*

Course Outcomes: At the end of the course, the student will be able to

CO1	Understand basic elements of practical spectroscopy, i.e., signal-to-noise ratio, resolving power, width and intensity of spectral transitions.
CO2	Understand many electron atoms and interaction of spins, i.e., LS and JJ coupling.
CO3	Understand effect of external fields to spectra like, Lande's-factor and Anomalous Zeeman effect.
CO4	Understand rotational, vibrational, electronic and Raman spectra of molecules and their applications.
CO5	Understand working of IR spectrometer, Raman spectrometer and principles of electron spin resonance, NMR and Mossbauer spectroscopy.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	1	2	1	2	1	2	3	2	2
CO2	2	2	1	2	2	1	1	1	1	3	3	1
CO3	3	2	2	2	1	1	2	1	1	3	1	1
CO4	2	2	2	2	1	1	2	1	1	3	3	3
CO5	2	2	2	2	1	1	2	1	1	3	1	1

PART A

UNIT I

Atomic structure: Atomic models, Electron orbits, Atomic spectra, The Bohr Model, Energy level and Spectra, Correspondence principle, Effect of Nuclear motion, Atomic excitation, Many electron atoms, Exclusion Principle, electron spin, X-ray spectra. **(12 Lectures)**

UNIT-II

Hydrogen and Alkali Spectra: Quantum theory of hydrogen atom, Series in hydrogen, nuclear mass effect, elliptical orbits, Sommerfeld model, spin-orbit coupling, relativistic correction, and Lamb shift (qualitative). Alkali Spectra and intensity ratios in doublets, LS-Coupling scheme, normal triplets, basic assumptions of the theory, identification of terms, selection rules, jj-coupling, Lande's interval rule, Selection rules, intensity ratios, regularities in complex spectra. Normal and anomalous Zeeman and Paschen Back effects, intensity rules. **(16 Lectures)**

PART B

Unit-III

Molecular structure: Bonding mechanism, Types of bonds, Classification of electronic states in molecules: Orbital angular momentum, electronic energy and potential curves, resolution of total energy, Vibrational Structure of Electronic transitions. Vibrational analysis, Rotational Structure of Electronic bands: General relations, branches of a band, band-head formation, Intensity distribution in a vibrational band system. Franck-Condon Principle and its wave mechanical formulation. **(15 Lectures)**

UNIT IV

Infrared and Raman Spectroscopy: Rigid rotator, energy levels, spectrum, intensity of rotational lines, Harmonic oscillator: energy levels, eigenfunctions, spectrum, Raman effect, Rotational and Vibrational Raman spectrum. Infrared and Raman Spectrum, Vibrational frequency, and force constants. Non-rigid rotator including symmetric top: energy levels, spectrum, Vibrating-rotator energy levels, Infrared and Raman spectrum, Symmetry properties of rotational levels. **(15 Lectures)**

Recommended Books:

1. Atomic Spectra: H. Kuhn (Longman Green) 1969.
2. Molecular Spectra and Molecular Structure I: G. Herzberg (Van-Nostrand Rein-hold), 1950.
3. Atomic Spectra: H.E. White (McGraw Hill) 1934.
4. Fundamentals of Molecular spectroscopy: Banwell and McCash (Tata McGraw Hill), 1994.
5. Molecular Spectroscopy: S. Chandra (Narosa), 2009.
6. Atomic, Molecular and Photons, Wolfgang Damtrodes (Springer), 2010.

PHYSICS-DSE -2	**BSHP-316-21**	**Nuclear Physics**	**L-5, T-1, P-0**	**6 Credits**

Pre-requisite: Understanding of senior secondary level Physics and Mathematics

Course Objectives: *The course contents cover general properties of nuclei, nuclear models, radioactive decays, nuclear reactions, fission and fusion processes and applications, interaction of gamma ray, charged particles and neutrons radiation with matter and respective detectors.*

Course Outcomes: At the end of the course, the student will be able to

CO1	Understand the ideas of basics of nucleus and their energy.
CO2	Understand the procedures for nuclear fission and fusion.
CO3	Understand the relationship between various types of couplings.
CO4	Ability to have insight into the interplay between theory, models, and data from modern experiments and into how the major open questions are being addressed.
CO5	A basic understanding of nuclear properties and models that describe the quantum structure, decay, and reactions of nuclei.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	1	2	2	2	2	2	3	2	2
CO2	2	2	1	2	1	2	2	1	3	3	2	1
CO3	3	2	2	2	1	1	2	2	3	3	2	2
CO4	2	2	2	2	1	1	2	2	1	3	1	2
CO5	2	2	2	2	1	1	2	2	1	3	1	2

Detailed Syllabus

PART A

UNIT-I

General Properties of Nuclei: Constituents of nucleus and their Intrinsic properties, quantitative facts about mass, radii, charge density (matter density), binding energy, average binding energy and its variation with mass number, main features of binding energy versus mass number curve, N/A plot, angular momentum, parity, magnetic moment, electric moments, nuclear excites states.

Radioactivity decay: (α) Alpha decay: basics of α-decay processes, radioactive series, tunnel theory of α emission, Gamow factor, Geiger Nuttall law, α-decay spectroscopy. (b) β-decay: β-, β+, EC decays, beta energy spectrum, end point energy, Gamma decay: Gamma rays' emission & kinematics, internal conversion. **(16 Lectures)**

UNIT-II

Nuclear Models: Liquid drop model approach, semi empirical mass formula and significance of its various terms, condition of nuclear stability, two nucleon separation energies, Fermi gas model (degenerate fermion gas, nuclear symmetry potential in Fermi gas), evidence for nuclear shell structure, nuclear magic numbers, basic assumption of shell model, concept of mean field, residual interaction, concept of nuclear force, Meson theory of nuclear forces. **(14 Lectures)**

PART B

UNIT-III

Nuclear Reactions: Types of Reactions, Coulomb scattering (Rutherford scattering), Coulomb barrier, Conservation Laws, kinematics of reactions, Q-value, reaction rate, reaction cross section, Concept of compound and direct Reaction, resonance reaction.

Fission and Fusion: Nuclear reactors, Breeder reactors, nuclear fusion in stars, formation of heavier elements, nuclear reactor accidents – Chernobyl and Fukushima, nuclear weapons, Fusion reactors, International thermonuclear experimental reactor (ITER). **(15 Lectures)**

UNIT-IV

Interaction of radiation and charged particles with matter: Interaction of gamma rays with matter - photoelectric effect, Compton scattering, pair production, Energy loss of electrons and positrons, Positron annihilation in condensed media, Stopping power and range of heavier charged particles, derivation of Bethe-Bloch formula, neutron interaction with matter.

Nuclear Detectors: Gas-filled detectors: ionization chamber, proportional counter and GM Counter. Basic principle of Organic and Inorganic scintillation detectors for gamma and electron radiation, photo-multiplier tube, Semiconductor detectors, Solid state nuclear track detectors, Neutron detector, Cherenkov detector, radiation monitoring devices. **(15 Lectures)**

Reference Books:

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. Concepts of Modern Physics by Arthur Beiser, Shobit Mahajan and S. Rai Choudhury (Tata Mcgraw Hill, 2006).
4. Modern Physics by J. Bernstein, Paul M. Fishbane, S. G. Gasiorowicz (Pearson, 2000).
5. Introduction to the physics of Nuclei & Particles, R.A. Dunlap. (Thomson Asia, 2004).
6. Basic ideas and concepts in Nuclear Physics - An Introductory Approach by K. Heyde (IOP-Institute of Physics Publishing, 2004).
7. Radiation detection and measurement, G.F. Knoll (John Wiley & Sons, 2000).
8. Physics and Engineering of Radiation Detection, Syed Naeem Ahmed (Academic Press, Elsevier, 2007).
9. Theoretical Nuclear Physics, J.M. Blatt & V.F.Weisskopf (Dover Pub.Inc., 1991).

PHYSICS-DSE -3	**BSHP-317-21**	**DISSERTATION**	**L-5, T-1, P-0**	**6 Credits**

Pre-requisite: Understanding of Physics and Mathematics

Course Objectives:

Course Outcomes: At the end of the course, the student will be able to

CO1	Explain the significance and value of problem in physics, both scientifically and in the wider community.
CO2	Design and carry out experiments as well as accurately record the results of experiments.
CO3	Critically analyse and evaluate experimental strategies and decide which is most appropriate for answering specific questions.
CO4	Research and communicate scientific knowledge in the context of a topic related to physics.
CO5	Explore new areas of research in physics and allied fields of science and technology.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	1	-	2	2	1	2	3	2	2
CO2	2	2	1	2	1	1	1	1	1	3	3	1
CO3	3	2	2	2	1	2	2	1	1	3	3	2
CO4	2	2	2	2	1	2	2	1	1	3	2	2
CO5	2	2	2	2	1	2	2	1	1	3	2	2

Guidelines:

- The aim of project work in B.Sc. (H.S.) 5th semester is to expose the students to Instrumentation, Power Electronics, Microcontroller, Digital communication.
- It may include development of pulse processing electronic modules, power supplies, software-controlled equipment in a research laboratory, or fabrication of a device. Project work based on participation in some ongoing research activity or analysis of data or review of some research papers is included.
- A student will work under the guidance of a faculty member from the department before the end of the 5th semester.
- A report of nearly 40 pages about the work done in the project (typed on both the sides of the paper and properly bound) will be submitted by a date to be announced by the Department.
- Assessment of the work done under the project will be carried out by a committee based on grasp of the problem assigned, efforts put in the execution of the project, degree of interest shown in learning the methodology, report prepared, and viva-voce/seminar, etc., as per guidelines.

PHYSICS-DSE-4	**BSHP-318-21**	**COMMUNICATION ELECTRONICS**	**L-5, T-1, P-0**	**Credits**

Pre-requisite: Understanding of senior secondary level Physics and Mathematics

Course Objectives: *The fundamental objectives of this course are to make the student understand and use the basic concepts of the circuits found in radiocommunications, be able to interpret and analyze the characteristics of the main components of communication electronics and be able to design the simplest devices and transmitting the signals.*

Course Outcomes: At the end of the course, students will be able to

CO1	Introduced to the communication methods means and modes.
CO2	Compare the performance of AM, FM and PM schemes with reference to SNR
CO3	Understand noise as a random process and its effect on communication receivers
CO4	Evaluate the performance of PCM, DPCM and DM in a digital communication system
CO5	Identify source coding and channel coding schemes for a given communication link

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	1	-	1	2	1	2	3	2	2
CO2	2	2	1	2	1	1	1	1	1	3	1	1
CO3	3	2	2	2	1	1	2	1	1	3	1	1
CO4	2	2	2	2	1	1	2	1	1	3	1	1
CO5	2	2	2	2	1	1	2	1	1	3	1	1

PART A

UNIT-I

Electronic communication: Introduction to communication – means and modes. Need for modulation. Block diagram of an electronic communication system. Basic principles of propagation of e. m. waves through atmosphere and ionosphere, Brief idea of frequency allocation for radio communication system in India (TRAI). Electromagnetic communication spectrum, band designations and usage. Channels and base-band signals. Concept of Noise, signal-to- noise (S/N) ratio. **(10 Lectures)**

UNIT-II

AM Transmission and Reception: Mathematical analysis of AM, Power content of sidebands and carrier, Generation of AM signals, switching modulator, square law modulation, double sideband suppressed carrier modulation, Ring modulator, Coherent detection, Costas receiver, Receiver Parameters; Selectivity, Sensitivity, Fidelity, Super heterodyne Receiver. Generation of SSB signals; Filter method, Phase-shift Method, Demodulation of SSB-SC signals. Transmission and

reception of vestigial side band signals.

FM Transmission and Reception: Frequency Modulation (FM) and Phase Modulation (PM), modulation index and frequency spectrum, FM allocation standards, generation of FM signals, Direct and Indirect FM, Diode reactance modulator, Phase-Locked-Loop, Armstrong method, RC phase shift method, Frequency stabilized reactance FM transmitter. Frequency demodulators tuned circuit frequency discriminators; FM stereo multiplexing, FM detection using PLL.

(16 Lectures)

PART B

UNIT-III

Analog Pulse Modulation: Channel capacity, Sampling theorem, Basic Principles-PAM, PWM, PPM, modulation and detection technique for PAM only, Multiplexing.

Digital transmission – Need for digital transmission, Pulse code modulation, Sampling, Aliasing, quatisation error, Digital carrier modulation and demodulation techniques: Information capacity, Shannon limit of information capacity, ASK, FSK, PSK, Differential encoder and decoder, Differential PSK, modulators and detectors, Scrambling and descrambling.

Advanced communication: Overview of picture and sound transmission and reception, channel band width, television standards, Block diagram of T.V. receivers, Concept of colour picture transmission. **(15 Lectures)**

UNIT-IV

Satellite Communication: Introduction, need, Geosynchronous satellite orbits, geostationary satellite advantages of geostationary satellites. Satellite visibility, transponders (C - Band), path loss, ground station, simplified block diagram of earth station. Uplink and downlink. FDMA, TDMA, CDMA, SDMA.

Mobile Telephony System – Basic concept of mobile communication, frequency bands used in mobile communication, concept of cell sectoring and cell splitting, SIM number, IMEI number, need for data encryption, architecture (block diagram) of mobile communication network, simplified block diagram of mobile phone handset, 2G, 3G 4G and 5G concepts (qualitative only). GPS navigation system (qualitative idea only) **(14 Lectures)**

Reference Books:

1. Communication Systems: B.P. Lathi, Wiley Eastern Limited.
2. Communication Systems, S. Haykin, 2006, Wiley India
3. Principles of Communication Systems: Taub and Schilling, John Wiley and Sons.
4. Electronic Communications, D. Roddy and J. Coolen, Pearson Education India.
5. Advanced Electronics Communication Systems- Tomasi, 6th edition, Prentice Hall.
6. Electronic Communication systems, G. Kennedy, 3rd Edn., 1999, Tata McGraw Hill.
7. Principles of Electronic communication systems – Frenzel, 3rd edition, McGraw Hill
8. Electronic Communication system, Blake, Cengage, 5th edition.
9. Wireless communications, Andrea Goldsmith, 2015, Cambridge University Press
10. Digital Computer Electronics: Albert P. Malvino, Jerald A Brown Tata-McGraw Hill.
11. Digital signal Transmission: C.C. Bissell and D.A. Chapman, Cambridge University Press.

PHYSICS-DSE -5	**BSHP-319-21**	**RENEWABLE ENERGY AND ENERGY HARVESTING**	**L-5, T-1, P-0**	**6 Credits**

Pre-requisite: Understanding of senior secondary level Physics and Mathematics

Course Objectives: *The aim of this course is not just to impart theoretical knowledge to the students but to provide them with exposure and hands-on learning wherever possible*

Course Outcomes: At the end of the course, the student will be able to

CO1	Understand the energy demand of world & distinguish between traditional and alternative form of energy.
CO2	Describe the concept of solar energy radiation and thermal applications.
CO3	Analyze making of solar cell and its types.
CO4	Identify hydrogen as energy source, its storage and transportation methods.
CO5	Compare wind energy, wave energy and ocean thermal energy conversion.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	1	-	1	2	2	2	3	2	2
CO2	2	2	1	2	1	1	1	1	1	3	1	1
CO3	3	2	2	2	1	1	2	2	1	3	2	2
CO4	2	2	2	2	1	1	2	2	1	3	2	1
CO5	2	2	2	2	1	1	2	2	1	3	2	1

PART A

UNIT-I

Introduction to alternate sources of energy: Fossil fuels and nuclear energy, their limitation, need of renewable energy, non-conventional energy sources. Renewable energy source, Types of renewable energy, zero-carbon or low-carbon energy, Working of renewable energy sources: Solar energy, Wind energy, Hydro energy, Tidal energy, Geothermal energy, Biomass energy, biochemical conversion, biogas generation, geothermal energy tidal energy, Hydroelectricity. Scope and future of renewable energy. **(11 Lectures)**

Unit II

Solar energy and solar cell: Solar energy, its importance, storage of solar energy, solar pond, non-convective solar pond, applications of solar pond and solar energy, solar water heater, flat plate collector, solar distillation, solar cooker, solar green houses, solar cell, absorption air conditioning. Need and characteristics of photovoltaic (PV) systems, PV models and equivalent

circuits, and sun tracking systems.

Wind Energy harvesting: Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces, and grid interconnection topologies.

(13 Lectures)

PART B

UNIT-III

Hydrogen Energy: Solar hydrogen through photo electrolysis and photocatalytic process, Physics of material characteristics for production of solar hydrogen.

Production storage and transportation: Storage processes, solid state hydrogen storage materials, structural and electronic properties of storage materials, new storage modes, safety factors, use of hydrogen as fuel; use in vehicles and electric generation, fuel cells, hydride batteries. **(15 Lectures)**

UNIT-IV

Ocean Energy: Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices, Tide characteristics and Statistics, Tide Energy Technologies, Ocean Thermal Energy, Osmotic Power, Ocean Bio-mass, Geothermal Energy: Geothermal Resources, Geothermal Technologies. Hydro Energy: Hydropower resources, hydropower technologies, environmental impact of hydro power sources.

Piezoelectric Energy harvesting: Introduction, Physics and characteristics of piezoelectric effect, materials, and mathematical description of piezoelectricity, Piezoelectric parameters and modeling piezoelectric generators, Piezoelectric energy harvesting applications, Electromagnetic Energy Harvesting: Linear generators, physics mathematical models, recent applications.

(15 Lectures)

Demonstrations and Experiments

1. Demonstration of Training modules on Solar energy, wind energy, etc.
2. Conversion of vibration to voltage using piezoelectric materials
3. Conversion of thermal energy into voltage using thermoelectric modules.

Reference Books:

1. Non-conventional energy sources - G.D Rai - Khanna Publishers, New Delhi
2. Solar energy - M P Agarwal - S Chand and Co. Ltd.
3. Solar energy - Suhas P Sukhative Tata McGraw - Hill Publishing Company Ltd.
4. Godfrey Boyle, "Renewable Energy, Power for a sustainable future", 2004, Oxford University Press, in association with The Open University.
5. Dr. P Jayakumar, Solar Energy: Resource Assesment Handbook, 2009
6. J.Balfour, M.Shaw and S. Jarosek, Photovoltaics, Lawrence J Goodrich (USA).

SEMESTER-VI

PHYSICS-C-13	**BSHP-321-21**	**ELECTROMAGNETIC THEORY**	**L-5, T-1, P-0**	**6 Credits**

Pre-requisite: Understanding of basic physics, electricity and magnetism, vector algebra.

Course Objectives: *Electromagnetic theory based on Maxwell's equations establishes the basic principle of electrical and electronic circuits over the entire frequency spectrum.*

Course Outcomes: At the end of the course, the student will be able to

CO1	Analyze the relation between electrostatics & magnetostatics, Biot-Sarvat law, Ampere's law, Faraday's Electromagnetic induction & verify with vector and scalar potential
CO2	Basic ideas about plane waves, their properties, linear, circular and elliptical electromagnetic waves
CO3	Examine the phenomena of wave propagation in different media and its interfaces
CO4	Analyze the nature of electromagnetic wave propagation in guided medium which are used in microwave applications.
CO5	Ability to describe and make calculations of plane electromagnetic waves in homogeneous media, including reflexion of such waves in plane boundaries between homogeneous media.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	1	-	1	2	1	2	3	2	2
CO2	2	2	1	2	1	1	1	1	1	3	3	1
CO3	3	2	2	2	1	1	2	1	1	3	3	2
CO4	2	2	2	2	1	1	2	1	1	3	1	2
CO5	2	2	2	2	1	1	2	1	1	3	1	2

Detailed Syllabus

PART A

UNIT-I

Maxwell Equations: Review of Maxwell's equations. Displacement Current. Vector and Scalar Potentials. Gauge Transformations: Lorentz and Coulomb Gauge. Boundary Conditions at Interface between Different Media. Wave Equations. Plane Waves in Dielectric Media. Poynting Theorem and Poynting Vector. Electromagnetic (EM) Energy Density. Physical Concept of Electromagnetic Field Energy Density, Momentum Density and Angular Momentum Density. **(12 Lectures)**

UNIT-II

EM Wave Propagation in Unbounded Media: Plane EM waves through vacuum and isotropic dielectric medium, transverse nature of plane EM waves, refractive index and dielectric constant, wave impedance. Propagation through conducting media, relaxation time, skin depth.

EM Wave in Bounded Media: Boundary conditions at a plane interface between two media. Reflection & Refraction of plane waves at plane interface between two dielectric media-Laws of Reflection & Refraction. Reflection & Transmission coefficients. Fresnel's Formulae for perpendicular & parallel polarization cases. **(10 Lectures)**

PART B

UNIT-III

Polarization of Electromagnetic Waves: Description of Linear, Circular and Elliptical Polarization. Propagation of E.M. Waves in Anisotropic Media. Symmetric Nature of Dielectric Tensor. Fresnel's Formula. Uniaxial and Biaxial Crystals. Light Propagation in Uniaxial Crystal. Double Refraction. Polarization by Double Refraction. Nicol Prism. Ordinary & extraordinary refractive indices. Production & detection of Plane, Circularly and Elliptically Polarized Light. Phase Retardation Plates: Quarter-Wave and Half-Wave Plates. Babinet Compensator and its Uses. Analysis of Polarized Light. **(12 Lectures)**

UNIT-IV

Wave Guides: Planar optical wave guides. Planar dielectric wave guide. Condition of continuity at interface. Phase shift on total reflection. Eigenvalue equations. Phase and group velocity of guided waves. Field energy and Power transmission.

Optical Fibres: Introduction, Brewster's law. Acceptance angle, Numerical Aperture. Step index and Graded Index. Single and Multiple Mode Fibres, material dispersion and pulse broadening in optical fibre, fible connector, splicer and couplers, application of optical fiber. **(15 Lectures)**

Reference Books:

1. Introduction to Electrodynamics, D.J. Griffiths, 3rd Ed., 1998, Benjamin Cummings.
2. Elements of Electromagnetics, M.N.O. Sadiku, 2001, Oxford University Press.
3. Introduction to Electromagnetic Theory, T.L. Chow, 2006, Jones & Bartlett Learning
4. Fundamentals of Electromagnetics, M.A.W. Miah, 1982, Tata McGraw Hill
5. Electromagnetic field Theory, R.S. Kshetrimayun, 2012, Cengage Learning
6. Electromagnetic Field Theory for Engineers & Physicists, G. Lehner, 2010, Springer
7. Electromagnetic Fields & Waves, P.Lorrain & D.Corson, 1970, W.H. Freeman & Co.
8. Electromagnetics, J.A. Edminster, Schaum Series, 2006, Tata McGraw Hill.
9. Electromagnetic field theory fundamentals, B. Guru and H. Hiziroglu, 2004, Cambridge University Press.

PHYSICS-C-14	**BSHP-322-21**	**STATISTICAL MECHANICS**	**L-3, T-1, P-0**	**4 Credits**

Pre-requisite: Understanding of senior secondary level Physics and Mathematics

Course Objectives: *The aim of the course is to familiarize the students with the idea of statistical mechanics and it's implications.*

Course Outcomes: At the end of the course, the student will be able to

CO1	Understand the Principles of Thermodynamics and Statistical Mechanics-ensemble theories and simple examples.
CO2	Understand the relation between microscopic and macroscopic description through statistical mechanics, know and can apply the laws of thermodynamics and principles of free energy
CO3	Boson gases--black body radiation, Debye theory, Bose-Einstein condensation
CO4	understand statistics of particles and statistics of fields,
CO5	understand various models in statistical mechanics, and apply them

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	1	-	1	2	1	2	3	2	2
CO2	2	2	1	2	1	1	1	1	1	3	1	1
CO3	3	2	2	2	1	1	2	1	1	3	2	2
CO4	2	2	2	2	1	1	2	1	1	3	1	2
CO5	2	2	2	2	1	1	2	1	1	3	1	2

PART A

UNIT-I

Classical Statistics: Macrostate & Microstate, Elementary Concept of Ensemble, Phase Space, Entropy and Thermodynamic Probability, Maxwell-Boltzmann Distribution Law, Partition Function, Thermodynamic Functions of an Ideal Gas, Classical Entropy Expression, Gibbs Paradox, Sackur Tetrode equation, Law of Equipartition of Energy with proof – Applications to Specific Heat and its Limitations, Thermodynamic Functions of a Two-Energy Levels System, Negative Temperature.

(11 Lectures)

UNIT-III

Classical Theory of Radiation: Properties of Thermal Radiation. Blackbody Radiation. Pure temperature dependence. Kirchhoff's law. Stefan-Boltzmann law: Thermodynamic proof. Radiation Pressure. Wien's Displacement law. Wien's Distribution Law. Saha's Ionization Formula. Rayleigh-Jean's Law. Ultraviolet Catastrophe.

Quantum Theory of Radiation: Spectral Distribution of Black Body Radiation. Planck's Quantum Postulates. Planck's Law of Blackbody Radiation: Experimental Verification. Deduction of (1) Wien's Distribution Law, (2) Rayleigh-Jeans Law, (3) Stefan-Boltzmann Law, (4) Wien's Displacement law from Planck's law. **(10 Lectures)**

PART B

UNIT-III

Bose-Einstein Statistics: B-E distribution law, Thermodynamic functions of a strongly Degenerate Bose Gas, Bose Einstein condensation, properties of liquid He (qualitative description), Radiation as a photon gas and Thermodynamic functions of photon gas. Bose derivation of Planck's law. **(9 Lectures)**

UNIT-IV

Fermi-Dirac Statistics: Fermi-Dirac Distribution Law, Thermodynamic functions of a Completely and strongly Degenerate Fermi Gas, Fermi Energy, Electron gas in a Metal, Specific Heat of Metals, Relativistic Fermi gas, White Dwarf Stars, Chandrasekhar Mass Limit. **(15 Lectures)**

Reference Books:

1. Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University Press.
2. Statistical Physics, Berkeley Physics Course, F. Reif, 2008, Tata McGraw-Hill.
3. Statistical and Thermal Physics, S. Lokanathan and R.S. Gambhir. 1991, Prentice Hall.
4. Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W. Sears and Gerhard L. Salinger, 1986, Narosa.
5. Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer.
6. An Introduction to Statistical Mechanics & Thermodynamics, R.H. Swendsen, 2012, Oxford Univ. Press.

PHYSICS-C	**BSHP-323-21**	**PHYSICS LAB-VIII**	**L-0, T-0, P-4**	**2 Credits**

Pre-requisite: Understanding of senior secondary level Physics and Mathematics

Course Objectives: *The laboratory should help the student develop a broad array of basic skills and tools of experimental physics and data analysis.*

Course Outcomes: At the end of the course, the student will be able to

CO1	Able to verify the theoretical concepts/laws learnt in theory courses.
CO2	Trained in carrying out precise measurements and handling sensitive equipment.
CO3	Understand the methods used for estimating and dealing with experimental uncertainties and systematic "errors".
CO4	Learn to draw conclusions from data and develop skills in experimental design.
CO5	Document a technical report which communicates scientific information in a clear and concise manner.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	1	2	1	2	1	2	3	2	2
CO2	2	2	1	2	2	1	1	1	1	3	3	1
CO3	3	2	2	2	2	1	2	1	1	3	2	2
CO4	2	2	2	2	2	1	2	1	1	3	2	2
CO5	2	2	2	2	1	1	2	1	1	3	2	2

Note: Students are expected to perform 8-10 experiments from the list taking at least 2-3 from the virtual lab.

List of Experiments:

1. To verify the law of Malus for plane polarized light.
2. To determine the specific rotation of sugar solution using Polarimeter.
3. To analyze elliptically polarized Light by using a Babinet's compensator.
4. To study dependence of radiation on angle for a simple Dipole antenna.
5. To determine the wavelength and velocity of ultrasonic waves in a liquid (Kerosene Oil, Xylene, etc.) by studying the diffraction through ultrasonic grating.
6. To study the reflection, refraction of microwaves.
7. To study Polarization and double slit interference in microwaves.
8. To determine the refractive index of liquid by total internal reflection using Wollaston's air-film.

9. To determine the refractive Index of (1) glass and (2) a liquid by total internal reflection using a Gaussian eyepiece.

10. To study the polarization of light by reflection and determine the polarizing angle for air-glass interface.
11. To verify the Stefan`s law of radiation and to determine Stefan's constant.
12. To determine the Boltzmann constant using V-I characteristics of PN junction diode.

Reference Books

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
3. A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
4. Electromagnetic Field Theory for Engineers & Physicists, G. Lehner, 2010, Springer

PHYSICS-DSE -6	**BSHP-324-21**	**PARTICLE PHYSICS**	**L-5, T-1, P-0**	**6 Credits**

Pre-requisite: Understanding of senior secondary level Physics and Mathematics

Course Objectives: *The course contents cover the elementary particles, cosmic rays, particle properties and their reactions, evolution of universe, Particle accelerators, colliding beams, and detectors for high energy physics.*

Course Outcomes: At the end of the course, the student will be able to

CO1	Understand basic knowledge about the Standard Model of elementary particles and interactions.
CO2	Ability to apply fundamental conservation laws and symmetries to judge the viability of production and decay processes for nuclei and elementary particles.
CO3	To impart the knowledge of fundamental particles, and fundamental interactions.
CO4	Understand the roles of nuclear and particle physics in energy production, medicine, and astrophysics - for example how to search for dark matter and how to understand the origin of the elements in the universe.
CO5	To impart the knowledge of concept of particles and how they are produced.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	1	2	1	2	1	2	3	3	2
CO2	2	2	1	2	1	1	1	1	1	3	3	2
CO3	3	2	2	2	1	1	2	1	1	3	3	2
CO4	2	2	2	2	1	1	2	1	1	3	3	1
CO5	2	2	2	2	1	1	2	1	1	3	3	1

Detailed Syllabus

PART A

UNIT-I

Elementary Particles: Historical introduction, fermions and bosons, particles and antiparticles, Classification of elementary particles and their interactions -electromagnetic, weak, strong, and gravitational interactions.

Cosmic Connection: Cosmic rays, sources of cosmic rays and production of secondary cosmic rays in atmosphere, Van allen radiation belt, Carbon-14 and other isotopic datings, soft and hard cosmic rays, cosmic ray experiments: discovery of particles, Brief about ground-based experiments: GRAPES. **(16 Lectures)**

UNIT-II

Symmetries and Conservation Laws: Invariance in classical mechanics and quantum mechanics, Energy, momentum, and angular momentum**,** Parity, baryons number, lepton number, Isospin, strangeness and charm, Charge conjugation, Time reversal invariance, CPT theorem, concept of quark model and color quantum number. **(13 Lectures)**

PART B

UNIT-III

Particle Properties and their reactions: Properties and lifetime of muon, pions: Determination of mass, spin, and parity. Lifetime of neutral pion and isotopic spin. Strange particles: V particles, charged K-mesons, mass and lifetime for charged K-mesons. Observations of different strange particles, strange particle production and decay. Strangeness and Hypercharge. **(15 Lectures)**

UNIT-IV

Particle Accelerators: Accelerators, Ion sources, Introduction to beam optics, beamline components – magnets and vacuum systems. Linear accelerator, Cockroft accelerator, Van-de Graaff generator, Tandem accelerator, Cyclotron, Electron synchrotron, Accelerator facilities in India. Introduction to colliding beam machines CERN LHC facility.

Detectors: Nuclear emulsions, Bubble chamber, Cloud chamber, Position-sensitive gas-filled and scintillator detectors, electromagnetic calorimeter, and hadron calorimeter. **(15 Lectures)**

Reference Books:

1. Introduction to High Energy Physics, D.H. Perkins, Cambridge Univ. Press.
2. Introduction to Elementary Particles, D. Griffith, John Wiley & Sons.
3. Quarks and Leptons, F. Halzen and A.D. Martin, Wiley India, New Delhi.
4. Radiation detection and measurement, G.F. Knoll (John Wiley & Sons, 2000).
5. Physics and Engineering of Radiation Detection, Syed Naeem Ahmed (Academic Press, Elsevier, 2007).
6. Concepts of Modern Physics by Arthur Beiser, Shobit Mahajan and S. Rai Choudhury (Tata Mcgraw Hill, 2006).
7. Modern Physics by J. Bernstein, Paul M. Fishbane, S. G. Gasiorowicz (Pearson, 2000).

PHYSICS-DSE -7	BSHP-325-21	ADVANCED MATHEMATICAL PHYSICS	L-5, T-1, P-0	6 Credits

Pre-requisite: Understanding of senior secondary level Physics and Mathematics

Course Objectives: *The emphasis of the course is on applications in solving problems of interest to physicists. Students are to be examined based on problems, seen and unseen.*

Course Outcomes: At the end of the course, the student will be able to

CO1	Develop knowledge and understanding of the concept that quantum states live in a vector space.
CO2	Develop the understanding and need for linear transformation.
CO3	understand the concept and have learned the basic skills in using linear algebra, vector calculus and tensor analysis in solving physics problems.
CO4	Use the concept of Calculus of Variations & Variational Principle.
CO5	Understand the vector and tensor analysis provides a kind of bridge between elementary aspects of linear algebra, geometry and analysis.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	1	-	1	2	3	2	3	2	2
CO2	2	2	1	2	1	1	1	3	3	3	2	2
CO3	3	2	2	2	1	1	2	3	3	3	2	2
CO4	2	2	2	2	1	1	2	3	1	3	2	1
CO5	2	2	2	2	1	1	2	3	1	3	1	1

Detailed Syllabus

PART A

UNIT-T

Linear Algebra: Vector Spaces: Vector Spaces over Fields of Real and Complex numbers. Examples. Vector space of functions. Linear independence of vectors. Basis and dimension of a vector space. Change of basis. Subspace. Isomorphisms. Inner product and Norm. Inner product of functions: the weight function. Triangle and Cauchy Schwartz Inequalities. Orthonormal bases. Sine and cosine functions in a Fourier series as an orthonormal basis. Gram Schmidt orthogonalisation. **(12 Lectures)**

UNIT-II

Linear Transformations: Introduction. Identity and inverse. Singular and non-singular transformations. Representation of linear transformations by matrices. Similarity transformation. Linear operators. Differential operators as linear operators on vector space of functions. Commutator of operators. Orthogonal and unitary operators and their matrix representations. Adjoint of a linear operator. Hermitian operators and their matrix representation. Hermitian differential operators and boundary conditions. Examples. Eigenvalues and eigenvectors of linear operators. Properties of eigenvalues and eigenvectors of Hermitian and unitary operators. Functions of Hermitian operators/ matrices. (**8 Lectures)**

PART B

UNIT-III

Tensors: Tensors as multilinear transformations (functionals) on vectors. Examples: Moment of Inertia, dielectric susceptibility. Components of a tensor in basis. Symmetric and antisymmetric tensors. The completely antisymmetric tensor. Non-orthonormal and reciprocal bases. Summation convention. Inner product of vectors and the metric tensor. Coordinate systems and coordinate basis vectors. Reciprocal coordinate basis. Components of metric in a coordinate basis and association with infinitesimal distance. Change of basis: relation between coordinate basis vectors. Change of tensor components under change of coordinate system. Example: Inertial coordinates & bases in Minkowski space, Lorentz transformations as coordinate transformations, Electromagnetic tensor and change in its components under Lorentz transformations. **(8 Lectures)**

UNIT-IV

Calculus of Variations & Variational Principle: Euler's Equation. Application to Simple Problems (shape of a soap film, Fermat's Principle, etc.). Several Dependent Variables and Euler's Equations. Example: Hamilton's Principle and the Euler-Lagrange equations of motion. Geodesics: geodesic equation as a set of Euler's equations.

Constrained Variations: Variations with constraints. Applications: motion of a simple pendulum, particle constrained to move on a hoop. **(12 Lectures)**

Reference Books:

1. Mathematical Tools for Physics, James Nearing, 2010, Dover Publications
2. Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, and F.E. Harris, 1970, Elsevier.
3. Introduction to Matrices and Linear Transformations, D.T. Finkbeiner, 1978, Dover Pub.
4. Linear Algebra, W. Cheney, E.W.Cheney & D.R.Kincaid, 2012, Jones & Bartlett Learning
5. Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole
6. Mathematical Methods for Physicis & Engineers, K.F.Riley, M.P.Hobson, S.J.Bence, 3rd Ed., 2006, Cambridge University Press.

PHYSICS-DSE -8	**BSHP-326-21**	**ADVANCED CONDENSED MATTER PHYSICS**	**L-5, T-1, P-0**	**6 Credits**

Pre-requisite: Understanding of senior secondary level Physics and Mathematics

Course Objectives: *The aim of the proposed course is to introduce the basic notion of the condensed matter physics and to familiarize the students with the various aspects of the interactions effects.*

Course Outcomes: At the end of the course, the student will be able to

CO1	Explain the significance and value of condensed matter physics.
CO2	The subject will be useful to gain an understanding of the interplay between classical – and quantum mechanical phenomena, and how microscopic/atomic processes acting between many atoms/molecules produces the typical properties of different solid-state matter.
CO3	Understand the Defects in crystals.
CO4	Learn the basic techniques of synthesis and characterization of nanostructure materials.
CO5	Critically analyse and evaluate experimental strategies and decide which is most appropriate for answering specific questions.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	1	-	1	2	1	2	3	2	2
CO2	2	2	1	2	1	1	1	1	1	3	1	1
CO3	3	2	2	2	1	1	2	1	1	3	1	1
CO4	2	2	2	2	1	1	2	1	1	3	1	1
CO5	2	2	2	2	1	1	2	1	1	3	1	1

PART A

UNIT-I

Crystal Types and Crystal Binding Ionic crystals: Types: Ionic crystals, Covalent crystals, Metal crystals, Molecular crystals, Hydrogen-Bonded crystals. Calculations of binding energies in Ionic crystals, Covalent crystals, Metal crystals, and the crystals of inert gases

Elastic Constants of Crystals: Analysis of stress. Analysis of strain. Dilation. Elastic compliance and stiffness constants. Elastic energy density. Elastic stiffness constants of cubic crystals. Elastic Waves in Cubic Crystals. Waves in [100], [110], and [111] directions. Experimental determination of elastic constants. **(15 Lectures)**

UNIT-II

Defects in crystals: Point Defects, Impurities, Vacancies, Schottky and Frenkel intrinsic vacancies, Extrinsic vacancies, Diffusion through solids, Measurement of diffusion constant and its applications, Kirkendall effect, Colour centers and coloration of crystals, F-center model, V-centers, Colour centers produced by other treatments.

Line Defects (or the Dislocations), Geometry of dislocations, Edge dislocation, Screw dislocations, Burgers vector, Stress fields of dislocations: dislocation energy, Dislocation densities, Shear strength of single crystals, Slip, Plastic deformation. **(15 Lectures)**

PART B

UNIT-III

NANOSCALE SYSTEMS: Length scales in physics, Nanostructures: 1D, 2D and 3D nanostructures (nanodots, thin films, nanowires, nanorods), Band structure and density of states of materials at nanoscale, Size Effects in nano systems, Quantum confinement: Applications of Schrodinger equation- Infinite potential well, potential step, potential box, quantum confinement of carriers in 3D, 2D, 1D nanostructures and its consequences. **(12 Lectures)**

UNIT-IV

SYNTHESIS OF NANOSTRUCTURE MATERIALS: Top-down and bottom-up approach, Photolithography. Ball milling. Gas phase condensation. Vacuum deposition. Physical vapor deposition (PVD): Thermal evaporation, E-beam evaporation, Pulsed Laser deposition. Chemical vapor deposition (CVD). Sol-Gel. Electro deposition. Spray pyrolysis. Hydrothermal synthesis. Preparation through colloidal methods. MBE growth of quantum dots.

CHARACTERIZATION: X-Ray Diffraction. Optical Microscopy. Scanning Electron Microscopy. Transmission Electron Microscopy. Atomic Force Microscopy. Scanning Tunneling Microscopy. **(16 Lectures)**

Reference books:

1. C.P. Poole, Jr. Frank J. Owens, Introduction to Nanotechnology (Wiley India Pvt. Ltd.).
2. S.K. Kulkarni, Nanotechnology: Principles & Practices (Capital Publishing Company)
3. K.K. Chattopadhyay and A. N. Banerjee, Introduction to Nanoscience and Technology (PHI Learning Private Limited).
4. Richard Booker, Earl Boysen, Nanotechnology (John Wiley and Sons).
5. M. Hosokawa, K. Nogi, M. Naita, T. Yokoyama, Nanoparticle Technology Handbook (Elsevier, 2007).
6. Bharat Bhushan, Springer Handbook of Nanotechnology (Springer-Verlag, Berlin, 2004).

PHYSICS-DSE -9	**BSHP-327-21**	**EXPERIMENTAL TECHNIQUES**	**L-5, T-1, P-0**	**6 Credits**

Pre-requisite: Understanding of senior secondary level Physics and Mathematics

Course Objectives: *The aim of course is to introduce students to basic experimental techniques, measurement theory and experiment design. The primary goal is to develop an appreciation of the role and significance of experimentation in the field of science. Students will be exposed to some widely employed experimental techniques and be introduced to some of the instrumentation that is used in experimental physics research.*

Course Outcomes: At the end of the course, the student will be able to

CO1	mastered the use of digital multimeters and oscilloscopes to measure DC and AC voltages and currents.
CO2	mastered the assessment of reasonable experimental uncertainty in a variety of different measurements and understood how to minimize that uncertainty.
CO3	rigorously analyzed experimental data using accepted error analysis methodologies to verify theoretical predictions.
CO4	Use the tools, methodologies, language and conventions of physics to test and communicate ideas and explanations.
CO5	learned to efficiently search the scientific literature and critically assess the scientific merit of what they read.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	1	2	1	2	1	2	3	2	2
CO2	2	2	1	2	2	1	1	1	1	3	2	2
CO3	3	2	2	2	2	2	2	1	2	3	2	2
CO4	2	2	2	2	1	1	2	1	2	3	1	1
CO5	2	2	2	2	1	1	2	1	1	3	2	2

PART A

UNIT-I

Measurements: Accuracy and precision. Significant figures. Error and uncertainty analysis. Types of errors: Gross error, systematic error, random error. Statistical analysis of data (Arithmetic mean, deviation from mean, average deviation, standard deviation, chi-square) and curve fitting. Gaussian distribution. **(10 Lectures)**

UNIT-II

Signals and Systems: Periodic and aperiodic signals. Impulse response, transfer function and frequency response of first and second order systems. Fluctuations and Noise in measurement system. S/N ratio and Noise figure. Noise in frequency domain. Sources of Noise: Inherent fluctuations, Thermal noise, Shot noise, 1/f noise.

Shielding and Grounding: Methods of safety grounding. Energy coupling. Grounding. Shielding: Electrostatic shielding. Electromagnetic Interference. **(14 Lectures)**

PART B

UNIT-III

Transducers & industrial instrumentation (working principle, efficiency, applications): Static and dynamic characteristics of measurement Systems. Generalized performance of systems, Zero order first order, second order and higher order systems. Electrical, Thermal and Mechanical systems. Calibration. Transducers and sensors. Characteristics of Transducers. Transducers as electrical element and their signal conditioning. Temperature transducers: RTD, Thermistor, Thermocouples, Semiconductor type temperature sensors (AD590, LM35, LM75) and signal conditioning. Linear Position transducer: Strain gauge, Piezoelectric. Inductance change transducer: Linear variable differential transformer (LVDT), Capacitance change transducers. Radiation Sensors: Principle of Gas filled detector, ionization chamber, scintillation detector.

(16 Lectures)

UNIT-IV

Digital Multimeter: Comparison of analog and digital instruments. Block diagram of digital multimeter, principle of measurement of I, V, C. Accuracy, and resolution of measurement.

Impedance Bridges and Q-meter: Block diagram and working principles of RLC bridge. Q-meter and its working operation. Digital LCR bridge.

Vacuum Systems: Characteristics of vacuum: Gas law, Mean free path. Application of vacuum. Vacuum system- Chamber, Mechanical pumps, Diffusion pump & Turbo Modular pump, Pumping speed, Pressure gauges (Pirani, Penning, ionization). **(12 Lectures)**

Reference Books:

1. Measurement, Instrumentation and Experiment Design in Physics and Engineering,
2. M. Sayer and A. Mansingh, PHI Learning Pvt. Ltd.
3. Experimental Methods for Engineers, J.P. Holman, McGraw Hill
4. Introduction to Measurements and Instrumentation, A.K. Ghosh, 3rd Edition, PHI Learning Pvt. Ltd.
5. Transducers and Instrumentation, D.V.S. Murty, 2nd Edition, PHI Learning Pvt. Ltd.
6. Instrumentation Devices and Systems, C.S. Rangan, G.R. Sharma, V.S.V. Mani, Tata McGraw Hill
7. Principles of Electronic Instrumentation, D. Patranabis, PHI Learning Pvt. Ltd.
8. Electronic circuits: Handbook of design & applications, U.Tietze, Ch.Schenk, Springer

PHYSICS-DSE-10	**BSHP-328-21**	**RADIATION SAFETY**	**L-5, T-1, P-0**	**6 Credits**

Pre-requisite: Understanding of senior secondary level Physics and Mathematics

Course Objectives: *The aim of this course is for awareness and understanding regarding radiation hazards and safety. The list of laboratory skills and experiments listed below the course are to be done in continuation of the topics.*

Course Outcomes: At the end of the course, the student will be able to

CO1	Understand the basics of nuclear and particle physics.
CO2	Students will demonstrate knowledge of radiation safety.
CO3	Students will use critical thinking and problem-solving skills to understand the impact of radiation hazardous.
CO4	Compare the effects of radiation has on a variety of biological and non-biological materials.
CO5	account for the role of radiation physics in a societal context, including climate and environmental challenges.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	1	-	3	2	1	2	3	2	2
CO2	2	2	1	2	1	3	1	1	1	3	3	2
CO3	3	2	2	2	1	3	2	1	1	3	3	1
CO4	2	2	2	2	1	3	2	1	1	3	3	1
CO5	2	2	2	2	1	3	2	1	1	3	2	1

Detailed Syllabus:

PART A

UNIT-I

Basics of Atomic and Nuclear Physics: Basic concept of atomic structure; X rays characteristic and production; concept of bremsstrahlung and auger electron, The composition of nucleus and its properties, mass number, isotopes of element, spin, binding energy, stable and unstable isotopes, law of radioactive decay, Mean life and half-life, basic concept of alpha, beta and gamma decay, concept of cross section and kinematics of nuclear reactions, types of nuclear reaction, Fusion, fission. **(15 Lectures)**

UNIT-II

Interaction of Radiation with matter: Types of Radiation: Alpha, Beta, Gamma and Neutron and their sources, sealed and unsealed sources, Interaction of Photons - Photo- electric effect, Compton Scattering, Pair Production, Linear and Mass Attenuation Coefficients, Interaction of Charged Particles: Heavy charged particles - Beth-Bloch Formula, Scaling laws, Mass Stopping Power, Range, Straggling, Channeling and Cherenkov radiation. Beta Particles- Collision and Radiation loss (Bremsstrahlung), Interaction of Neutrons- Collision, slowing down and Moderation. **(15 Lectures)**

PART B

UNIT-III

Radiation detection and monitoring devices: Radiation Quantities and Units: Basic idea of different units of activity, KERMA, exposure, absorbed dose, equivalent dose, effective dose, collective equivalent dose, Annual Limit of Intake (ALI) and derived Air Concentration (DAC). Radiation detection: Basic concept and working principle of gas detectors (Ionization Chambers, Proportional Counter, Multi-Wire Proportional Counters (MWPC) and Gieger Muller Counter), Scintillation Detectors (Inorganic and Organic Scintillators), Solid States Detectors and Neutron Detectors, Thermo luminescent Dosimetry. **(15 lectures)**

UNIT-IV

Radiation safety management: Biological effects of ionizing radiation, Operational limits and basics of radiation hazards evaluation and control: radiation protection standards, International Commission on Radiological Protection (ICRP) principles, justification, optimization, limitation, introduction of safety and risk management of radiation. Nuclear waste and disposal management. Brief idea about Accelerator driven Sub-critical system (ADS) for waste management.

Application of nuclear techniques: Application in medical science (e.g., MRI, PET, Projection Imaging Gamma Camera, radiation therapy), Archaeology, Art, Crime detection, Mining and oil. Industrial Uses: Tracing, Gauging, Material Modification, and Food preservation. **(15 Lectures)**

Reference Books:

1. W.E. Burcham and M. Jobes – Nuclear and Particle Physics – Longman (1995)
2. G.F.Knoll, Radiation detection and measurements
3. Thermoluninescense Dosimetry, Mcknlay A.F., Bristol, Adam Hilger (Medical Physics Handbook)
4. W.J. Meredith and J.B. Massey, "Fundamental Physics of Radiology". John Wright and Sons, UK, 1989.
5. J.R. Greening, "Fundamentals of Radiation Dosimetry", Medical Physics Hand-Book Series, No.6, Adam Hilger Ltd., Bristol 1981.
6. Practical Applications of Radioactivity and Nuclear Radiations, G.C. Lowental and P.L. Airey, Cambridge University Press, U.K., 2001
7. A. Martin and S.A. Harbisor, An Introduction to Radiation Protection, John Willey & Sons, Inc. New York, 1981.
8. W.R. Hendee, "Medical Radiation Physics", Year Book – Medical Publishers Inc. London, 1981.

Comparison of Credit system with UGC

		UGC			IKG PTU		
Type of course	**Nomenclature**	**Credits in Theory**	**Credits in Practical**	**Total Credits**	**Credits in Theory**	**Credits in Practical**	**Total Credits**
Core courses	PHYSICS-C	14*4=56	14*2=28	84	14*4=56	13*2=26	82
Electives	Department Specific Elective (PHYSICS-DSE)	4*4=16	4*2=8	24	4*6=24	-	24
	General Elective (GE)	14*4	14*2	24	6*4=24	3*3=6	30
Ability Enhancement Course	Ability Enhancement Compulsory (AEC)	2*2	-	04	5*2=10	-	10
	Skill Enhancement Elective Course (PHYSICS-SEC)	2*2	-	04	2*2=4	-	04
	Total credits			**140**			**150**