I.K. Gujral Punjab Technical University

Agenda

Board of Studies (Physical Sciences,

Nano-science and Engineering)

at

Department of Physical Sciences

IKG, Punjab Technical University, Kapurthala

On Friday 29 July 2022, 11:00 AM

Agenda for the Board of Studies (Physical Sciences, Nano science and Engineering), IKGPTU to be held on Friday July 29, 2022 at Department of Physical Sciences, I.K. Gujral Punjab Technical University, Kapurthala at

Contents

Study Scheme and Syllabus
B.Sc. (Hons.) Physics

Comparison

	UGC			IKG PTU		
Type of course	**Credits in Theory**	**Credits in Practical**	**Total Credits**	**Credits in Theory**	**Credits in Practical**	**Total Credits**
Core courses	**14*4=56**	**14*2=28**	**84**	**14*4=56**	**13*2=26**	**82**
Electives: 1. Department Specific Elective (DSE)	**4*4=16**	**4*2=8**	**24**	**4*6=24**	**-**	**24**
2. General Elective (GE)	**14*4**	**14*2**	**24**	**6*4=24**	**3*3=6**	**30**
3. Ability Enhancement Course (AEC)	**2*2**	**-**	**04**	**5*2=10**	**-**	**10**
4. Skill Enhancement Course (SEC)	**2*2**	**-**	**04**	**2*2=4**	**-**	**04**
Total credits			**140**			**150**

First Semester

Course Code	Course Title	Type of course	Load Allocation			Marks Distribution		Total Marks	Cr
			L	T	P	Internal	External		
BSHP-111-21	Optics	**Core Course**	**3**	**1**	**-**	**40**	**60**	**100**	**4**
BSHP-112-21	Mechanics		**3**	**1**	**-**	**40**	**60**	**100**	**4**
BSHP-113-21	Physics Lab-I		**-**	**-**	**4**	**30**	**20**	**50**	**2**
BSHM-114-21	Calculus	**General Elective**	**3**	**1**	**-**	**40**	**60**	**100**	**4**
BSHC-112-21	Inorganic Chemistry		**3**	**1**	**-**	**40**	**60**	**100**	**4**
BSHC-113-21	Chemistry Lab-I		-	-	**4**	**30**	**20**	**50**	**2**
BHHH-105-21	Communicative English-I	**Ability Enhancement Compulsory**	**2**	**-**	**-**	**20**	**30**	**50**	**2**
BSHH-106A-21 BSHH-106B-21	Punjabi Compulsory-I or Mudhli Punjabi-I		**2**	**-**	**-**	**20**	**30**	**50**	**2**
TOTAL			**16**	**4**	**8**	**260**	**340**	**600**	**24**

Second Semester

Course Code	Course Title	Type of course	Load Allocation			Marks Distribution		Total Marks	Cr
			L	T	P	Internal	External		
BSHP-121-21	Waves and Vibrations	**Core Course**	**3**	**1**	**-**	**40**	**60**	**100**	**4**
BSHP-122-21	Electricity and Magnetism		**3**	**1**	**-**	**40**	**60**	**100**	**4**
BSHP-123-21	Physics Lab-II		**-**	**-**	**4**	**30**	**20**	**50**	**2**
BSHM-204-21	Mathematics	**General Elective**	**3**	**1**	**-**	**40**	**60**	**100**	**4**
BSHC-102-21	Organic Chemistry		**3**	**1**	**-**	**40**	**60**	**100**	**4**
BSHC-102-21	Chemistry Lab-II		-	-	**4**	**30**	**20**	**50**	**2**
BSHH-205-21	Communicative English -II	**Ability Enhancement Compulsory**	**2**	**-**	**-**	**20**	**30**	**50**	**2**
BSHH-206A-21 BSHH-206A-21	Punjabi Compulsory-II or Mudhli Punjabi-II		**2**	**-**	**-**	**20**	**30**	**50**	**2**
TOTAL			**16**	**4**	**8**	**260**	**340**	**600**	**24**

Third Semester

Course Code	Course Title	Type of course	Load Allocation			Marks Distribution		Total Marks	Cr
			L	T	P	Internal	External		
BSHP-211-21	Mathematical Physics-I	**Core Courses**	**5**	**1**	**-**	**50**	**100**	**150**	**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**
BSHP-214-21	Analog Systems and Application		**3**	**1**	**-**	**40**	**60**	**100**	**4**
BSHP-215-21	Physics Lab-IV		**-**	**-**	**4**	**30**	**20**	**50**	**2**
BHCP-204-21	Physical Chemistry	**General Elective**	**3**	**1**	**-**	**40**	**60**	**100**	**4**
BHCL-208-21	Chemistry Lab-III		**-**	**-**	**4**	**30**	**20**	**50**	**2**
BSHP-216-21 BSHP-217-21 BSHP-218-21	Skill Enhancement Course-I	**Skill Enhancement Course**	**2**	**-**	**-**	**20**	**30**	**50**	**2**
TOTAL			**16**	**4**	**12**	**280**	**370**	**650**	**26**

Fourth semester

Course Code	Course Title	Type of course	Load Allocation			Marks Distribution		Total Marks	Cr
			L	T	P	Internal	External		
BSHP-221-21	Mathematical Physics-II	**Core Courses**	**5**	**1**	**-**	**50**	**100**	**150**	**6**
BSHP-221-21	Thermal Physics		**3**	**1**	**-**	**40**	**60**	**100**	**4**
BSHP-223-21	Physics Lab-V		**-**	**-**	**4**	**30**	**20**	**50**	**2**
BSHP-224-21	Digital Electronics		**3**	**1**	**-**	**40**	**60**	**100**	**4**
BSHP-225-21	Physics Lab-VI		**-**	**-**	**4**	**30**	**20**	**50**	**2**
BSHM-408-21	Matrices & Ordinary Differential Equations	**General Elective**	**4**	**1**	**-**	**40**	**60**	**100**	**4**
EVS-101A	Environment Science	**Ability Enhancement**	**-**	**-**	**4**	**30**	**20**	**50**	**2**
BSHP-226-21 BSHP-227-21 BSHP-228-21	Skill Enhancement course-II	**Skill Enhancement Course**	**2**	**-**	**-**	**20**	**30**	**50**	**2**
TOTAL			**17**	**4**	**12**	**280**	**370**	**650**	**26**

Fifth semester

Course Code	Course Title	Type of course	Load Allocation			Marks Distribution		Total Marks	Cr
			L	T	P	Internal	External		
BSHP-311-21	Quantum Mechanics	**Core Courses**	**5**	**1**	**-**	**50**	**100**	**150**	**6**
BSHP-312-21	Solid State Physics		**3**	**1**	**-**	**40**	**60**	**100**	**4**
BSHP-313-21	Physics Lab-VII		**-**	**-**	**4**	**30**	**20**	**50**	**2**
BSHP-314-21	Computational Physics Lab-I		-	-	**4**	**30**	**20**	**50**	**2**
BSHP-315-21 BSHP-316-21	DSE-1	**Department Specific Elective**	**5**	**1**	**-**	**50**	**100**	**150**	**6**
BSHP-317-21 BSHP-318-21 BSHP-319-21	DSE-2		**5**	**1**	**-**	**50**	**100**	**150**	**6**
Total			**18**	**4**	**8**	**250**	**400**	**650**	**26**

Sixth semester

Course Code	Course Title	Type of course	Load Allocation			Marks Distribution		Total Marks	Cr
			L	T	P	Internal	External		
BSHP-321-21	Electromagnetic Theory	**Core Course**	**5**	**1**	**-**	**50**	**100**	**150**	**6**
BSHP-322-21	Statistical Mechanics		**3**	**1**	**-**	**40**	**60**	**100**	**4**
BSHP-323-21	Physics Lab -VIII		**-**	**-**	**4**	**30**	**20**	**50**	**2**
BSHP-324-21 BSHP-325-21	DSE-3	**Department Specific Elective**	**5**	**1**	**-**	**50**	**100**	**150**	**6**
BSHP-326-21 BSHP-327-21 BSHP-328-21	DSE-4		**5**	**1**	**-**	**50**	**100**	**150**	**6**
Total			**18**	**4**	**4**	**220**	**380**	**600**	**24**

Skill Enhancement Courses-I

S. No.	Name of the Subject	Code
1	Workshop Skill Enhancement	BSHP-216-21
2	Computational Physics	BSHP-217-21
3	Weather Forecasting	BSHP-218-21

Skill Enhancement Courses-II

S. No.	Name of the Subject	Code
1	Electrical Circuits and Network Skills	BSHP-226-21
2	Basic Instrumentation Skills	BSHP-227-21
3	Scientific Word Processing	BSHP-228-21

Department Specific Electives-I

S. No.	Name of the Subject	Code
1	Atomic and Molecular Spectroscopy	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

Department Specific Electives-II

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

Semester-III

Physics – core-5	BSHP-211-21	Mathematical Physics-I	L-5, T-1, P-0	6 Credits

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

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: Interpolations-cubic spline fitting, Numerical differentiation – Lagrange interpolation, Numerical integration by Simpson and Weddle's rules, Random number generators, Numerical solution of differential equations by Euler, predictor- corrector and Runge-Kutta methods, eigenvalue problems. **(15 Lectures)**

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. **(8 Lectures)**

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 am intercept of a fitted line. (6 **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). **(8 Lectures)**

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. **(6 Lectures)**

Reference Books:

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

Objective: *The course content covers foundations of modern physics, experiments forming basis of quantum mechanics, Schrodinger equation and applications, uncertainty principle and applications.*

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, spin orbit coupling, X-ray spectra. Zeeman effect, Stern-Gerlach experiment. **(11 Lectures)**

UNIT -II

Dual Nature of Waves and Particles: Planck's quantum, Planck's constant, and light as a collection of photons; Blackbody Radiation: Quantum theory of Light; Photo-electric effect and Compton scattering. De Broglie wavelength and matter waves; Davisson-Germer experiment, Wave description of particles by wave packets. Group and Phase velocities and relation between them, Two-Slit experiment with electrons. Probability, Wave amplitude and wave functions, Physical interpretation of a wave function, probabilities, and normalization; Probability and probability current densities in one dimension.

(11 Lectures)

UNIT -III

Introduction to Quantum mechanics: Position measurement-gamma ray microscope thought experiment; Wave-particle duality, Heisenberg uncertainty principle (Uncertainty relations involving Canonical pair of variables): Derivation from Wave Packets impossibility of a particle following a trajectory; Estimating minimum energy of a confined particle using uncertainty principle; Energy-time uncertainty principle- application to virtual particles and range of interaction. **(8 Lectures)**

UNIT -IV

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)**

Reference Books:

1. Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.
2. Introduction to Modern Physics, Rich Meyer, Kennard, Coop, 2002, Tata McGraw Hill.
3. Introduction to Quantum Mechanics, David J. Griffith, 2005, Pearson Education.
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 - core	BSHP-213-21	PHYSICS LAB-III	L-0, T-0, P-4	2 Credits

Objective: *The laboratory experiments forming basis of quantum mechanics, photoelectric effect, ionization potential, measurement of absorption and emission spectra, diffraction, diffraction of light, change on electron, and tunneling effect.*

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 He-Ne 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-core-7	BSHP-214-21	ANALOG ELECTRONICS	L-3, T-1, P-0	4 Credits

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

UNIT-I

Semiconductor Diodes: P and N type semiconductors. Energy Level Diagram. Conductivity and Mobility, Concept of Drift velocity. 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. **(6 Lectures)**

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. **(6 Lectures)**

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. **(10 Lectures)**

Coupled Amplifier: Two stage RC-coupled amplifier and its frequency response. **(4 Lectures)**

Feedback in Amplifiers: Effects of Positive and Negative Feedback on Input Impedance, Output Impedance, Gain, Stability, Distortion and Noise. **(4 Lectures)**

UNIT-IV

Operational Amplifiers (Black Box approach): Characteristics of an Ideal and Practical Op- Amp. (IC 741) Open-loop and Closed-loop Gain. Frequency Response. CMRR. Slew Rate and concept of Virtual ground. **(4 Lectures)**

Applications of Op-Amps: (1) Inverting and non-inverting amplifiers, (2) Adder, (3) Subtractor, (4) Differentiator, (5) Integrator, (6) Log amplifier, (7) Zero crossing detector (8) Wein bridge oscillator. **(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-core	**BSHP-215-21**	**PHYSICS LAB-IV**	**L-0, T-0, P-4**	**2 Credits**

Objective: *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 and OPAMP based application circuits*

Students are expected to perform 10-12 experiments from the list taking at least 3-4 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.
13. To design inverting amplifier using Op-amp (741,351) and study its frequency response.
14. To design non-inverting amplifier using Op-amp (741,351) & study its frequency response.
15. To study the zero-crossing detector and comparator.
16. To add two dc voltages using Op-amp in inverting and non-inverting mode.
17. To design a precision Differential amplifier of given I/O specification using Op-amp.
18. To investigate the use of an op-amp as an Integrator.
19. To investigate the use of an op-amp as a Differentiator.
20. To design a circuit to simulate the solution of a 1st/2nd order differential equation.
21. To draw the characteristics of a given triode and to determine the tube parameters.
22. Calibration of a Si diode, a thermistor, and thermocouple for temperature measurements.
23. 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-Chemistry-5	BHCP-204-21	Physical Chemistry	L-3, T-1, P-0	4 Credits

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

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)-Chemistry-5	**BHCL-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 standardisation 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

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO1	-	3	-	-	3
CO2	-	3	-	-	3
CO3	-	3	-	-	3
CO4	-	3	-	-	3
CO5	-	3	-	-	3

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

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

Objective: *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.*

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)**

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]

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

Objective: *The aim of this course is not just to teach computer programming and numerical analysis but to emphasize its role in solving problems in Physics.*

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

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. **(7 Lectures)**

UNIT-II

Scientific Programming using C++/Python: Some fundamental Linux Commands (Internal and External commands). Development of FORTRAN, Basic elements of FORTRAN: Character Set, Constants and their types, Variables and their types, Keywords, Variable Declaration and concept of instruction and program. Operators: Arithmetic, Relational, Logical and Assignment Operators. Expressions: Arithmetic, Relational, Logical, Character and Assignment Expressions. Fortran Statements: I/O Statements (unformatted/formatted), Executable and Non- Executable Statements, Layout of Fortran Program, Format of writing Program and concept of coding, Initialization and Replacement Logic. Examples from physics problems. **(7 Lectures)**

UNIT-III

Control Statements: Types of Logic (Sequential, Selection, Repetition), Branching Statements (Logical IF, Arithmetic IF, Block IF, Nested Block IF, SELECT CASE and ELSE IF Ladder 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. **(4 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.

PHY-SEC-3	BSHP-218-21	WEATHER FORECASTING	L-2, T-0, P-0	2 Credits

Objective: *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*

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. **(9 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. **(4 Lectures)**

Weather systems: Global wind systems; air masses and fronts: classifications; jet streams; local thunderstorms; tropical cyclones: classification; tornadoes; hurricanes. **(3 Lectures)**

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. **(4 Lectures)**

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 (both 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-core-8	BSHP-221-21	MATHEMATICAL PHYSICS-II	L-5, T-1, P-0	6 Credits

Objective: *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.*

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)**

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, 3^{rd} 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, 7^{th} Ed. 2003, Tata McGraw-Hill
6. First course in complex analysis with applications, D.G. Zill and P.D. Shanahan, 1940, Jones & Bartlett

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

Objective: *The covers laws of thermodynamics and applications, Thermodynamic Potentials, Maxwell's Thermodynamic Relations, Kinetic theory of gases, molecular collisions, and transmission of heat*

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)**

Unit-III

Kinetic Theory of Gases: Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas and its Experimental Verification. Mean, RMS and Most Probable Speeds. Degrees of Freedom. Law of Equipartition of Energy (No proof required). Real Gases, Deviations of Ideal Gas Equation. The Virial Equation. Andrew's Experiments on CO_2 Gas. Critical Constants. Continuity of Liquid and Gaseous State.Vapour and Gas. Boyle Temperature. Van der Waal's Equation of State for Real Gases. 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)**

Unit-IV

Transmission of Heat: Basic Definitions Specific heats of Gases, Conduction-Coefficient of the thermal conductivity, Lee's disc method to find thermal conductivity of bad conductor, Blackbody radiation, Spectral distribution, Derivation of Planck's law, Deduction of Wien's distribution law, Rayleigh Jeans Law, Stefan Boltzmann Law, and Wien's displacement law from Planck's law. **(10 Lectures)**

Reference Books:

1. Brijlal, N. Subrahmanyam and P. S. Hemne, Heat, Thermodynamics and Statistical Physics, S. Chand, and Company, 2010.
2. Richard H Dittman and Zemansky MW, Heat and Thermodynamics, 3rd Special Edition, McGraw Hill, 2008.
3. Thermal Physics, S. Garg, R. Bansal and C. Ghosh, 1993, Tata McGraw-Hill.
4. A Treatise on Heat, Meghnad Saha, and B.N. Srivastava, 1969, Indian Press.
5. Thermodynamics, Enrico Fermi, 1956, Courier Dover Publications.

6. Thermodynamics, Kinetic theory & Statistical thermodynamics, F.W.Sears & G.L. Salinger, 1988, Narosa.
7. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
8. Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer.
9. Thermal Physics, A. Kumar and S.P. Taneja, 2014, R. Chand Publications.

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

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

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

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

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)**

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. **(11 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
9. Microprocessor Architecture Programming & applications with 8085, 2002, R.S. Goankar, Prentice Hall.

Physics – core	BSHP-225-21	PHYSICS LAB-VI	L-0, T-0, P-4	2 Credits

Objective: *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.*

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.
16. Write the following programs using 8085 Microprocessor
    (i) Addition and subtraction of numbers using direct addressing mode
    (ii) Addition and subtraction of numbers using indirect addressing mode
    (iii) Multiplication by repeated addition.
    (iv) Division by repeated subtraction.
    (v) Handling of 16-bit Numbers.
    (vi) Use of CALL and RETURN Instruction.
    (vii) Block data handling.
    (viii) Other programs (e.g., Parity Check, using interrupts, etc.).

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.
3. Microprocessor Architecture Programming and applications with 8085, R.S. Goankar, 2002, Prentice Hall.
4. Microprocessor 8085: Architecture, Programming and interfacing, A. Wadhwa, 2010, PHI Learning.

General Elective (GE) Mathematics-6	**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
CO1	2	2	2	2	2	2	2	2
CO2	2	2	2	2	2	2	2	1
CO3	2	2	2	2	2	2	2	1
CO4	2	2	2	2	1	2	2	1
CO5	2	2	2	2	1	1	1	1

Detailed Syllabus:

Course Title: Matrices & Ordinary Differential Equations
Course Code: UC-BSHM-408-19

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.

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:

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

Ability Enhancement Course (AEC)-5	**BHCL-205-21**	**ENVIRONMENTAL SCIENCE**	**L-2, T-0, P-0**	**2 Credits**

UNIT-I

Introduction to Environmental Studies: Multidisciplinary nature of Environmental Studies: Scope & Importance, Need for Public Awareness

Ecosystems: Concept of an Ecosystem: Structure & functions of an ecosystem, (Producers, Consumers & Decomposers) Energy Flow in an ecosystem: Food Chain, Food web and Ecological Pyramids, Characteristic features, structure & functions of following Ecosystems: Forest Ecosystem, Aquatic Ecosystem (Ponds, Lakes, River & Ocean) **(5 Lectures)**

UNIT-II

Natural Resources: Renewable & Non-renewable resources, Forest Resources: Their uses, functions & values (Biodiversity conservation, role in climate change, medicines) & threats (Overexploitation, Deforestation, Timber extraction, Agriculture Pressure), Forest Conservation Act Water Resources: Their uses (Agriculture, Domestic & Industrial), functions & values, Overexploitation and Pollution of Ground & Surface water resources (Case study of Punjab), Water Conservation, Rainwater Harvesting Land Resources: Land as a resource; Land degradation, soil erosion and desertification Energy Resources: Renewable & non-renewable energy resources, use of alternate energy resources (Solar, Wind, Biomass, Thermal), Urban problems related to Energy. **(5 Lectures)**

UNIT-III

Biodiversity & its conservation: Types of Biodiversity: Species, Genetic & Ecosystem India as a mega biodiversity nation, Biodiversity hot spots and biogeographic regions of India, Examples of Endangered & Endemic species of India, Red data book. **(4 Lectures)**

UNIT-IV

Environmental Pollution & Social Issues: Types, Causes, Effects & Control of Air, Water, Soil & Noise Pollution, Nuclear hazards and accidents & Health risks, Global Climate Change: Global warming, Ozone depletion, Acid rain, Melting of Glaciers & Ice caps, Rising sea levels. Environmental disasters: Earthquakes, Floods, Cyclones, Landslides.

Field Work: Visit to a National Park, Biosphere Reserve, Wildlife Sanctuary Documentation & preparation of a Biodiversity (flora & fauna) register of campus/river/forest

Visit to a local polluted site: Urban/Rural/Industrial/Agricultural Identification & Photography of resident or migratory birds, insects (butterflies) Public hearing on environmental issues in a village. **(5 Lectures)**

Reference Books

1. Bharucha, E. Textbook for Environmental Studies. University Grants Commission, New Delhi.
2. Agarwal, K.C. 2001 Environmental Biology, Nidi Publ. Ltd. Bikaner.
3. Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad – 380 013, India, Email:mapin@icenet.net
4. Brunner R.C., 1989, Hazardous Waste Incineration, McGraw Hill Inc. 480p
5. Clark R.S., Marine Pollution, Clanderson Press Oxford (TB)

6. Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T. 2001, Environmental Encyclopedia, Jaico Publ. House, Mumabai, 1196p
7. De A.K., Environmental Chemistry, Wiley Eastern Ltd.
8. Down to Earth, Centre for Science and Environment (R)
9. Gleick, H.P. 1993. Water in crisis, Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute Oxford Univ. Press. 473p
10. Hawkins R.E., Encyclopedia of Indian Natural History, Bombay Natural History Society, Bombay (R)
11. Heywood, V.H & Waston, R.T. 1995. Global Biodiversity Assessment. Cambridge Univ. Press 1140p.
12. Jadhav, H & Bhosale, V.M. 1995. Environmental Protection and Laws. Himalaya Pub. House, Delhi 284 p.
13. Mckinney, M.L. & School, R.M. 1996. Environmental Science systems & Solutions, Web enhanced edition. 639p.
14. Mhaskar A.K., Matter Hazardous, Techno-Science Publication (TB).
15. Miller T.G. Jr. Environmental Science, Wadsworth Publishing Co. (TB)
16. Odum, E.P. 1971. Fundamentals of Ecology. W.B. Saunders Co. USA, 574p
17. Rao M N. & Datta, A.K. 1987. Waste Water treatment. Oxford & IBH Publ. Co. Pvt. Ltd. 345p.
18. Sharma B.K., 2001. Environmental Chemistry. Geol Publ. House, Meerut
19. Survey of the Environment, The Hindu (M)
20. Townsend C., Harper J, and Michael Begon, Essentials of Ecology, Blackwell Science.

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

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

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. **(3 Lectures)**

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. **(4 Lectures)**

UNIT -II

Generators and Transformers: DC Power sources. AC/DC generators. Inductance, capacitance, and impedance. Operation of transformers. **(3 Lectures)**

Electric Motors: Single-phase, three-phase & DC motors. Basic design. Interfacing DC or AC sources to control heaters & motors. Speed & power of ac motor. **(3 Lectures)**

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. **(3 Lectures)**

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) **(4 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.

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

Objective: *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.*

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. **(4 Lectures)**

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. **(4 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. **(6 Lectures)**

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. **(3 Lectures)**

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. **(4 Lectures)**

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. **(3 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. **(3 Lectures)**

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. **(3 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

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

Objective: *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.*

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)**

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. To compile a frequency distribution and evaluate mean, standard deviation etc.
2. To evaluate sum of finite series and the area under a curve.
3. To find the product of two matrices
4. To find a set of prime numbers and Fibonacci series.
5. To write program to open a file and generate data for plotting using Gnuplot.
6. Plotting trajectory of a projectile projected horizontally.
7. Plotting trajectory of a projectile projected making an angle with the horizontally.
8. 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.
9. To find the roots of a quadratic equation.
10. Motion of a projectile using simulation and plot the output for visualization.
11. Numerical solution of equation of motion of simple harmonic oscillator and plot the outputs for visualization.
12. Motion of particle in a central force field and plot the output for visualization.

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

UNIT-I

Time dependent Schrodinger 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. **(8 Lectures)**

UNIT-II

Time independent Schrodinger 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. **(10 Lectures)**

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**.** **(12 Lectures)**

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. **(10 lectures)**

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. **(8 Lectures)**

UNIT-IV

Atoms in External Magnetic Fields: Normal and Anomalous Zeeman Effect. Paschen Back and Stark Effect (Qualitative Discussion only). **(4 Lectures)**

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. Term symbols. Spectra of Hydrogen and Alkali Atoms (Na etc.). **(10 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-core-12	BSHP-312-21	SOLID STATE PHYSICS	L-3, T-1, P-0	4 Credits

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, 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)**

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

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 - core	**BSHP-314-21**	**COMPUTATION PHYSICS LAB**	**L-0, T-0, P-4**	**2 Credits**

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

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. 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.
11. To find the roots of a quadratic equation.
12. Motion of a projectile using simulation and plot the output for visualization.
13. Numerical solution of equation of motion of simple harmonic oscillator and plot the outputs for visualization.
14. Motion of particle in a central force field and plot the output for visualization.
15. To find the determinant of a matrix and its eigenvalues and eigenvectors.
16. 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-DSE1	BSHP-315-21	ATOMIC AND MOLECULAR SPECTROSCOPY	L-5, T-1, P-0	6 Credits

***Objective**: The course contents cover the hydrogen and alkali spectra, coupling schemes, atoms in magnetic fields, Infrared and Raman spectroscopy, and electron spectra, line broadening mechanisms and Lasers.*

UNIT I

Hydrogen and Alkai Spectra: 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. **(15 Lectures)**

Unit-II Molecular Electronic Spectra: Classification of electronic states: 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 III

Infrared and Raman Spectra: Rigid rotator, energy levels, spectrum, intensity of rotational lines, Harmonic oscillator: energy levels, eigenfunctions, spectrum, Raman effect, Quantum theory of Raman effect, Rotational and Vibrational Raman spectrum. Anharmonic oscillator: energy levels, Infrared and Raman Spectrum, Vibrational frequency and force constants, Dissociation of molecules. Non-rigid rotator including symmetric top: energy levels, spectrum, Vibrating-rotator energy levels, Infrared and Raman spectrum, Symmetry properties of rotational levels, influence of nuclear spin, isotope effect on rotational spectra. **(15 Lectures)**

UNIT IV

Lasers : Temporal and spatial coherence, shape and width of spectral lines, line broadening mechanism, natural, collision and Doppler broadening, Laser Pumping and Resonators: Resonators, modes of a resonator, number of modes per unit volume, quality factor, threshold condition, Dynamics of the Laser Processes: Rate equations for two, three and four level systems, production of a giant pulse – Q switching, mode-locking, Types of Lasers: He-Ne gas laser, Nitrogen Laser, CO2 laser, Ruby laser, Semiconductor lasers, dye lasers, Applications: Holography, non-linear optics: harmonic generation, second harmonic generation, phase matching and optical mixing. **(15 Lectures)**
TUTORIALS: Problems pertaining to the topics covered in the course.

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.
7. Lasers and Non-linear Optics: B.B. Laud. (Wiley Eastern), 1991.
8. Principles of Lasers: O. Svelto (Plenum Press), 4th edition, 1998.
9. An Introduction to Lasers and their applications: D.C.O'Shea, W. Russell and W.T. Rhodes (Addition –Wesley), 1977.
10. Laser Theory and Applications: Thyagarajan and A. Ghatak (Plenum) 1981 (reprint: MacMillan)

Physics-DSE2	BSHP-316-21	Nuclear Physics	L-5, T-1, P-0	6 Credits

Objective: *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.*

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.

(10 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.

(12 Lectures)

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. **(12 Lectures)**

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. **(10 Lectures)**

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). **(9 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. **(12 Lectures)**

Detector for Nuclear Radiations: 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. **(10 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 – DSE3	**BSHP-317-21**	**DISSERTATION**	**L-5, T-1, P-0**	**6 Credits**

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. Scientists and Engineers from other departments of the university and Institutes can act as co-supervisors. A report of nearly 50 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 University. Assessment of the work done under the project will be carried out by a committee based on grasp of the problem assigned, effort 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 – DSE4	**BSHP-318-21**	**COMMUNICATION ELECTRONICS**	**L-5, T-1, P-0**	**6 Credits**

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. **(10 Lectures)**

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. **(12 Lectures)**

UNIT-III

Analog Pulse Modulation: Channel capacity, Sampling theorem, Basic Principles-PAM, PWM,

PPM, modulation and detection technique for PAM only, Multiplexing. **(5 Lectures)**
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. **(6 Lectures)**

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. **(4 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. **(7 Lectures)**

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 and 4G concepts (qualitative only). GPS navigation system (qualitative idea only) **(8 Lectures)**

TUTORIALS: Relevant problems on the topics covered in the course.

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 – DSE5	BSHP-319-21	RENEWABLE ENERGY AND ENERGY HARVESTING	L-5, T-1, P-0	6 Credits

Objective: 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

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)

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

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)**

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. Wave propagation through dilute plasma, electrical conductivity of ionized gases, plasma frequency, refractive index, skin depth, application to propagation through ionosphere. **(10 Lectures)**

UNIT-II

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. Fresnel's Formulae for perpendicular & parallel polarization cases, Brewster's law. Reflection & Transmission coefficients. Total internal reflection, evanescent waves. Metallic reflection (normal Incidence) **(10 Lectures)**

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

Rotatory Polarization: Optical Rotation. Biot's Laws for Rotatory Polarization. Fresnel's Theory of optical rotation. Calculation of angle of rotation. Experimental verification of Fresnel's theory. Specific rotation. Laurent's half-shade polarimeter. **(5 Lectures)**

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. **(8 Lectures)**

Optical Fibres: Numerical Aperture. Step index and Graded Index (Definitions Only). Single and Multiple Mode Fibres (Concept and Definition Only). **(3 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-core-14	**BSHP-322-21**	**STATISTICAL MECHANICS**	**L-3, T-1, P-0**	**4 Credits**

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. **(9 Lectures)**

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. **(5 Lectures)**

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.

(13 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 - core	BSHP-323-21	PHYSICS LAB-VIII	L-0, T-0, P-4	2 Credits

PHYSICS PRACTICAL

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

PHY-DSE6	BSHP-324-21	EXPERIMENTAL TECHNIQUES	L-5, T-1, P-0	6 Credits

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. **(7 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 **(7 Lectures)**

Shielding and Grounding: Methods of safety grounding. Energy coupling. Grounding. Shielding: Electrostatic shielding. Electromagnetic Interference. **(4 Lectures)**

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. **(21 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. **(5 Lectures)**

Impedance Bridges and Q-meter: Block diagram and working principles of RLC bridge. Q-meter and its working operation. Digital LCR bridge. **(4 Lectures)**

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

PRACTICALS-EXPERIMENTAL TECHNIQUES LAB

1. Determine output characteristics of a LVDT & measure displacement using LVDT
2. Measurement of Strain using Strain Gauge.
3. Measurement of level using capacitive transducer.
4. To study the characteristics of a Thermostat and determine its parameters.
5. Study of distance measurement using ultrasonic transducer.
6. Calibrate Semiconductor type temperature sensor (AD590, LM35, or LM75)
7. To measure the change in temperature of ambient using Resistance Temperature Device (RTD).
8. Create vacuum in a small chamber using a mechanical (rotary) pump and measure the chamber pressure using a pressure gauge.
9. Comparison of pickup of noise in cables of different types (co-axial, single shielded, double shielded, without shielding) of 2m length, understanding of importance of grounding using function generator of mV level & an oscilloscope.
10. To design and study the Sample and Hold Circuit.
11. Design and analyze the Clippers and Clampers circuits using junction diode
12. To plot the frequency response of a microphone.
13. To measure Q of a coil and influence of frequency, using a Q-meter.

Reference Books:

1. Electronic circuits: Handbook of design and applications, U. Tietze and C. Schenk, 2008, Springer
2. Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1990, Mc-Graw Hill
3. Measurement, Instrumentation and Experiment Design in Physics & Engineering, M. Sayer and A. Mansingh, 2005, PHI Learning.

Physics-DSE7	BSHP-325-21	PARTICLE PHYSICS	L-5, T-1, P-0	6 Credits

Objective: 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.

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. Symmetries and Conservation Laws: energy and momentum, angular momentum, parity, baryon number, Lepton number, Isospin, Strangeness and charm, Discovery of quarks, concept of quark flavor, color quantum number, Interactions among quarks, Yukawa theory, Field bosons, Standard model and beyond, Higgs boson. **(14 Lectures)**

UNIT-II

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. **(6 Lectures)**

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. **(12 Lectures)**

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. **(10 Lectures)**

Detectors: Nuclear emulsions, Bubble chamber, Cloud chamber, Position-sensitive gas-filled and scintillator detectors, electromagnetic calorimeter, and hadron calorimeter. **(5 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-DSE8	BSHP-326-21	ADVANCED MATHEMATICAL PHYSICS	L-5, T-1, P-0	6 Credits

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.

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)**

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-DSE9	BSHP-328-21	NANO MATERIALS AND APPLICATIONS	L-5, T-1, P-0	6 Credits

UNIT-I

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. **(10 Lectures)**

UNIT-II

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. **(8 Lectures)**

CHARACTERIZATION: X-Ray Diffraction. Optical Microscopy. Scanning Electron Microscopy. Transmission Electron Microscopy. Atomic Force Microscopy. Scanning Tunneling Microscopy. **(8 Lectures)**

UNIT-III

OPTICAL PROPERTIES: Coulomb interaction in nanostructures. Concept of dielectric constant for nanostructures and charging of nanostructure. Quasi-particles and excitons. Excitons in direct and indirect band gap semiconductor nanocrystals. Quantitative treatment of quasi-particles and excitons, charging effects. Radiative processes: General formalization-absorption, emission, and luminescence. Optical properties of heterostructures and nanostructures. **(14 Lectures)**

UNIT-IV

ELECTRON TRANSPORT: Carrier transport in nanostructures. Coulomb blockade effect, thermionic emission, tunneling and hoping conductivity. Defects and impurities: Deep level and surface defects. **(6 Lectures)**

APPLICATIONS: Applications of nanoparticles, quantum dots, nanowires and thin films for photonic devices (LED, solar cells). Single electron devices (no derivation). CNT based transistors. Nanomaterial Devices: Quantum dots heterostructure lasers, optical switching and optical data storage. Magnetic quantum well; magnetic dots - magnetic data storage. Micro Electromechanical Systems (MEMS), Nano Electromechanical Systems (NEMS). **(14 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).

PRACTICALS: Nano Materials and Applications

1. Synthesis of metal nanoparticles by chemical route.
2. Synthesis of semiconductor nanoparticles.
3. Surface Plasmon study of metal nanoparticles by UV-Visible spectrophotometer.
4. XRD pattern of nanomaterials and estimation of particle size.
5. To study the effect of size on color of nanomaterials.
6. To prepare composite of CNTs with other materials.
7. Growth of quantum dots by thermal evaporation.
8. Prepare a disc of ceramic of a compound using ball milling, pressing and sintering, and study its XRD.
9. Fabricate a thin film of nanoparticles by spin coating (or chemical route) and study transmittance spectra in UV-Visible region.
10. Prepare a thin film capacitor and measure capacitance as a function of temperature or frequency.
11. Fabricate a PN diode by diffusing Al over the surface of N-type Si and study its V-I characteristic.

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 & Technology (PHI Learning Private Limited).
4. Richard Booker, Earl Boysen, Nanotechnology (John Wiley and Sons).

Physics-DSE10	BSHP-328-21	RADIATION SAFETY	L-5, T-1, P-0	6 Credits

Objective: *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*

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)

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.

(10 Lectures)

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, Sterization, Food preservation.

(5 Lectures)

Experiments:

1. Study the background radiation levels using Radiation meter
2. Characteristics of Geiger Muller (GM) Counter:
3. Study of characteristics of GM tube and determination of operating voltage and plateau length using background radiation as source (without commercial source).
4. Study of counting statistics using background radiation using GM counter.

5. Study of radiation in various materials (e.g., KSO4 etc.). Investigation of possible radiation in different routine materials by operating GM at operating voltage.
6. Study of absorption of beta particles in Aluminum using GM counter.
7. Detection of α particles using reference source & determining its half-life using spark counter
8. Gamma spectrum of Gas Light mantle (Source of Thorium)

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 5)
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

PHS-909	Advanced Nuclear Physics	L-3, T-1, P-0	4 Credits

Pre-requisite: Understanding of post graduate level physics

Course Objectives: The objective of the course on **Advanced Nuclear Physics** is to equip the Ph.D. students with the knowledge about various sources of radiations, advances in nuclear structure field, advances in nuclear reaction field and various accelerator and detector techniques used in nuclear physics.

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

CO1	equipped with the knowledge of different sources of radiation
CO2	understand working of various accelerators and their applications
CO3	understand experimental techniques in nuclear reactions and structure
CO4	describe various measurements in nuclear physics and their outcomes
CO5	equipped with latest developments in the field of nuclear physics

Mapping of course outcomes with the program outcomes

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

Detailed Syllabus:

1. **Radiation Sources:** Neutron Sources: Alpha particle neutron sources, photo neutron sources, Accelerators, and nuclear reactors as sources of neutrons. Sources of Charged Particles: Fast electron source, Heavy charged particle sources, Sources of Electromagnetic Radiation: Gamma rays following Beta decay and nuclear reactions, Annihilation radiations, Bremsstrahlung, and characteristic X-rays.

2. **Accelerators:** Cyclotron, Synchrotrons, Tandem accelerator, Pelletron, Linear accelerator and Colliding beam accelerator.

3. **Experimental methods for probing nuclear structure:** Experimental methods for gamma-ray, beta and charged-particle spectroscopy, Coulomb excitation, Compton-suppressed Ge detectors, multiplicity filter, Advanced detector arrays-GAMMASPHERE and EUROBALL, Neutron arrays, Recoil mass-separator, Lifetime measurements-DSAM and RDM techniques, Coincidence method, Pulsed beam method.

4. **Nuclear Reactions:** Types of Nuclear Reactions and conservation laws, Energetics of nuclear reactions, Reaction cross-section, Elastic and inelastic scattering, Coulomb scattering, Direct reaction, Resonance reaction. Heavy ion reaction, Compound nucleus reaction, fusion-evaporation residue and fusion-fission process and cross-sections, Angular distribution measurements, Mass distribution measurements, light particle multiplicity measurements, spin distribution measurements.

Recommended Books:

1. Introductory Nuclear Physics: K.S. Krane, John Wiley & Sons, New York
2. Introductory Nuclear Physics: S.S.M. Wong, Prentice Hall of India, New Delhi.
3. Nuclear Physics: R. R. Roy and B. P. Nigam, New Age Pub., N. Delhi

Present syllabus of course on Electromagnetism

BTPH103-18	Electromagnetism	L-3, T-1, P-0	4 Credits

Pre-requisites (if any):

1. High-school education with physics as one of the subject.
2. Mathematical course on vector calculus.

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

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

CO1	Specify the constitutive relationships for fields and understand their important.
CO2	Describe the static and dynamic electric and magnetic fields for technologically important structures.
CO3	Measure the voltage induced by time varying magnetic flux.
CO4	acquire the knowledge of Maxwell equation and electromagnetic field theory and propagation and reception of electro-magnetic wave systems.
CO5	have a solid foundation in engineering fundamentals required to solve problems and also to pursue higher studies.

Detailed Syllabus:

PART-A

UNIT I: Electrostatics in vacuum and linear dielectric medium ***(10 lectures)***

Calculation of electric field and electrostatic potential for a charge distribution; Divergence and curl of electrostatic field; Laplace's and Poisson's equations for electrostatic potential; Uniqueness theorem (Definition); examples: Faraday's cage; Boundary conditions of electric field; Energy of a charge distribution and its expression in terms of electric field. Electrostatic field and potential of a dipole. Bound charges due to electric polarization in Dielectrics; Electric displacement; Solving simple electrostatics problems in presence of dielectrics – Point charge at the centre of a dielectric sphere, charge in front of a dielectric slab.

UNIT II: Magnetostatics in linear magnetic medium ***(10 lectures)***

Bio-Savart law, Divergence and curl of static magnetic field; Concept of vector potential, Magnetization and associated bound currents; auxiliary magnetic field $\vec{H}$; Boundary conditions on $\vec{B}$ and $\vec{H}$. Solving for magnetic field due to bar magnet; magnetic susceptibility and ferromagnetic, paramagnetic and diamagnetic materials; magnetic domains, hysteresis and B-H curve.

PART-B

UNIT III: Faraday's law and Maxwell's equations ***(10 lectures)***

Faraday's law; equivalence of Faraday's law and motional EMF; Lenz's law; Electromagnetic breaking and its applications; Differential form of Faraday's law; energy stored in a magnetic field. Continuity equation for current densities; Modifying equation for the curl of magnetic field to satisfy continuity equation; displacement current and magnetic field arising from time-dependent electric field; Maxwell's equation in vacuum and non-conducting medium; Flow of energy and Poynting vector and Poynting theorem.

UNIT IV: Electromagnetic waves *(10 lectures)*

Wave equation for electromagnetic waves in free space and conducting medium, Uniform plane waves and general solution of uniform plane waves, relation between electric and magnetic fields of an electromagnetic wave their transverse nature.; Linear, circular and elliptical polarization, Reflection and transmission of electromagnetic waves from a non-conducting medium-vacuum interface for normal incidence.

Text and Reference Books:

1. D. Griffiths, Introduction to Electrodynamics, Pearson Education India; 4th ed. (2015).
2. J D Jackson, Classical Electrodynamics, John Wiley and Sons (1999).
3. Halliday and Resnick, Fundamentals of Physics, Wiley (2011).
4. W. Saslow, Electricity, Magnetism and Light, Academic Press (2002).
5. HK Malik and AK Singh, Engineering Physics, 2nd ed., Tata McGraw Hill (2018).

Revised syllabus

BTPH103-22	Electromagnetism	L-3, T-1, P-0	4 Credits

Pre-requisites (if any):

1. High-school education with physics as one of the subject.
2. Mathematics course on vector calculus.

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

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

CO1	Specify the constitutive relationships for fields and understand their important.
CO2	Describe the static and dynamic electric and magnetic fields for technologically important structures.
CO3	Measure the voltage induced by time varying magnetic flux.
CO4	acquire the knowledge of Maxwell equation and electromagnetic field theory and propagation and reception of electro-magnetic wave systems.
CO5	have a solid foundation in engineering fundamentals required to solve problems and also to pursue higher studies.

Detailed Syllabus:

PART-A

UNIT I

Review of Vector Analysis: Addition, subtraction, components of vectors, scalar, and vector multiplications, triple products, three orthogonal coordinate systems (rectangular, cylindrical, and spherical), Conversion of a vector from one coordinate system to another, Vector calculus- differentiation, partial differentiation, integration, vector operator, del, gradient, divergence, and curl; Gauss-divergence theorem and Stoke's theorem (statement only). ***(10 Lectures)***

UNIT II

Electrostatics in vacuum and linear dielectric medium: Coulomb's law, Electric field intensity, electric flux, Electrical field due to point charges. Line, Surface, and Volume charge distributions. Gauss law and its applications. Absolute Electric potential, Potential difference, Calculation of potential differences for different configurations. Electric dipole, Electrostatic Energy and Energy density.

Current and current density, Ohms Law in Point form, Continuity of current, Boundary conditions, Permittivity of dielectric materials, Dielectric medium, dielectric polarization and its types, Displacement vector, Poisson's equation, Laplace's equation, Solution of Laplace, and Poisson's equation; Capacitance; capacitance of a spherical conductor and cylindrical capacitor. ***(10 Lectures)***

PART-B

UNIT-III

Magnetostatics in linear magnetic medium: Magnetic flux; magnetic flux density; Biot-Savart's law, Ampere's law of force, Ampere's circuital law, 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, calculations of inductances and mutual inductances for a solenoid and toroid, boundary conditions on magnetic fields. ***(10 Lectures)***

UNIT-IV

Maxwell's Equations and Electromagnetic Waves: Concept of displacement current and conduction current, Maxwell's equation-differential and Integral form, Poynting's theorem, its significance and Poynting's vector, Wave theory: Derivation of wave equation, uniform plane waves, Maxwell's equation, Wave equation in Phasor form, Plane waves in free space and in a homogenous material. Attenuation, phase and propagation constant, intrinsic impedance, Relation between E & H, wave equation for a conducting medium, Plane waves in lossy dielectrics, Propagation in good conductors, Skin effect. ***(12 Lectures)***

Text and Reference Books:

1. D. Griffiths, Introduction to Electrodynamics, Pearson Education India; 4th ed. (2015).
2. J D Jackson, Classical Electrodynamics, John Wiley and Sons (1999).
3. Halliday and Resnick, Fundamentals of Physics, Wiley (2011).
4. W. Saslow, Electricity, Magnetism and Light, Academic Press (2002).
5. HK Malik and AK Singh, Engineering Physics, 2nd ed., Tata McGraw Hill (2018).
6. M. N. O. Sadiku, "Elements of Electromagnetics", Oxford University Publication, 2014