K.R. MANGALAM UNIVERSITY
THE COMPLETE WORLD OF EDUCATION

SCHOOL OF BASIC AND APPLIED SCIENCES

Bachelor of Science (Hons) Physics

B.Sc. (Hons.) Physics

Programme Code: 09

2020-23

Approved in the 23rd Meeting of Academic Council Held on 23 June 2020

Academic Council K.R. Mangalam University Member Secretary

Registrar
K.R. Mangalam University
Sohna Road, Gurugram, (Haryana)

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Preamble

The objective of any programme at Higher Education Institute is to prepare their students for the society at large. The K. R. Mangalam University visualizes all its programmes in the best interest of their students and in this endeavor; it offers a new vision to all its Under-Graduate courses. It imbibes a Curriculum based credit system (CBCS) and Learning Outcome-based Curriculum Framework (LOCF) for all its Under Graduate programmes. The LOCF approach is envisioned to provide a focused, outcome-based syllabus at the undergraduate level with an agenda to structure the teaching-learning experiences in a more student-centric manner. The LOCF approach has been adopted to strengthen students' experiences as they engage themselves in the programme of their choice. The Under-Graduate Programmes will prepare the students for both, academia and employability. The programmes also state the attributes that it offers to inculcate at the graduation level. The graduate attributes encompass values related to emotional stability, well-being, critical thinking and also skills for employability.

The School acknowledges all the faculty members for their valuable contributions.

Dr. Diwakar Padalia Dr. Pawan Kumar Dr. Dilraj Preet Kaur

Dr. Nidhi Gaur Dr. Ruby Jindal Dr. Rajni Gautam

1. Introduction: About University

K.R. Mangalam University located on Sohna Road, Gurugram, is one of the fastest growing and most promising upcoming universities in India. It is a State Private University established in 2013 by an act of the legislature of the Haryana Government under Haryana Private Universities Act (Amendment) 8 of 2013.It is recognized by the UGC under Section 2f of the UGC Act, 1956. The primary aim of the University is to promote excellence in basic and professional education while upholding moral values.

KRMU offers various Undergraduate, Postgraduate and Doctoral Degree programs across different disciplines. The group of educational units in the University promote education in the areas of Engineering& Technology, Legal Studies, Basic and Applied Sciences, Management Sciences, Commerce, Journalism and Mass Communication, Hotel Management and Catering Technology, Medical and Allied Sciences, Architecture and Planning, Agriculture, Fashion Designing, Humanities and Education. All the disciplines follow a well-defined curriculum design keeping in view the guidelines of UGC/AICTE and appropriate regulatory bodies like Council of Architecture (COA), Bar Council of India (BCI), Pharmacy Council of India (PCI), National Council for Teachers Education (NCTE) etc., wherever applicable. All courses are semester and credit based.

Objectives

i. To impart undergraduate, post-graduate and Doctoral education in identified areas of higher education.
ii. To undertake research programs with industrial interface.
iii. To integrate its growth with the global needs and expectations of the major stake holders through teaching, research, exchange & collaborative programs with foreign, Indian Universities/Institutions and MNCs.
iv. To act as a nodal center for transfer of technology to the industry.
v. To provide job oriented professional education to the student community with particular focus on Haryana.

2. About School: SBAS

The school imparts out both teaching and research through its various elective science disciplines via Mathematics, Chemistry and Physics.

SBAS imparts students disciplinary knowledge, enhances their skills and ability, motivating them to think ingeniously, helping them to act independently and take decisions accordingly in all their scientific pursuits and other endeavors. It strives to empower its students and faculty members to contribute for the development of society and Nation.

The faculty is in constant touch with various experts in the relevant fields and is willing to experiment with latest ideas in teaching and research.

VISION

School of Basic and Applied Sciences intends for continuum growth as centre of advanced learning, research and innovation by disseminating analytical and scientific knowledge in the areas of basic and applied sciences by promoting interdisciplinary research and scientific acumen.

MISSION

M1: Enable students to be scientists/ academicians /entrepreneurs by accomplishing fundamental and advanced research in diverse areas of basic and applied sciences.

M2: Build strong associations with academic organizations/industries for knowledge creation, advancement, and application of scientific fervor.

M3: Create conducive environment for lifelong learning.

M4: Empower students to be socially responsible and ethically strong individuals through value-based science education.

3. Programme offered by School

School offers undergraduate B.Sc. (Hons) Programmes, postgraduate M.Sc. Programmes, and Doctoral Programmes. All these programmes are designed to impart scientific knowledge to the students and are aimed to provide theoretical as well as practical training in their respective fields.

3.1B.Sc. (Hons.) Physics

The undergraduate programme, B.Sc. (Hons.) Physics of SBAS is intended for students with a keen interest in either the theoretical or experimental aspects of frontline physics. This research-orientated program builds on the courses in physics, which aims to give students a deeper level of knowledge and understanding of the scientific methods and principles. The goals and objectives of this program are to widen student's horizon in understanding fundamental concepts and applications of physics, supporting their specialization in the field, and helping them expand their skills.

3.2. Graduate Attributes

GA1: To demonstrate competence in discipline specific theoretical and practical Knowledge
GA2: To develop creativity and innovation
GA3: To enhance communication and interpersonal skills
GA4: To enable critical & logical thinking and investigative research attitude amongst students
GA5: To develop ethical values, teamwork and lifelong learning approach

3.3 Eligibility Criteria: - The student should have passed the 10+2 examination conducted by the Central Board of Secondary Education or equivalent examination from a recognized Board in Science stream with an aggregate of 50% or more.

3.4 Course Outline: - Mathematical Physics / Mechanics / Electricity & Magnetism/Waves & Optics / Thermal Physics / Digital Systems & Applications/Elements of Modern Physics/Analog Systems & Applications/Quantum Mechanics & Applications / Electromagnetic Theory / Statistical Mechanics/ Solid State physics / Elementary Nuclear Physics/ Elementary Particle Physics/Applied Optics.

3.5 Career Options: - Opportunities exist in academics, research laboratories and administration besides all the opportunities applicable to any other graduate like UPSC examination's, defense services and other govt. jobs.

4. Program Duration

The minimum period required for the B.Sc. (Hons.) Physics course shall extend over a period of three Academic Years.
The maximum period for the completion of the B.Sc. (Hons) Physics course shall be five years.

5. Class Timings

The classes will be held from Monday to Friday from 09:10 am to 04:30 pm.

6. Scheme of Studies

Scheme of Studies as per Choice-Based Credit System and Learning Outcome-Based Curriculum Framework

ODD SEMESTER								
YEAR	**SN**	**COURSE CODE**	**COURSE TITLE**	**TEACHING SCHEDULE**			**CREDITS**	**Total Hours**
				L	**T**	**P**		
FIRST	1	BSEL155A	COMMUNICATION SKILLS	4	0	0	4	4
	2	BSDM301A	DISASTER MANAGEMENT	3	0	0	3	3
	3	BSCH125A	ENVIRONMENTAL STUDIES	3	0	0	3	3
	4		GENERIC ELECTIVE- I	4	2	0	6	4
	5	BSPH206A	ANALOG SYSTEMS AND APPLICATIONS	4	0	0	4	4
	6	BSPH256A	ANALOG SYSTEMS AND APPLICATIONS LAB	0	0	4	2	4
	7	BSPH105A	PHYSICS WORKSHOP SKILL	2	2	0	4	4
	TOTAL						**26**	**26**

EVEN SEMESTER							
SN	**COURSE CODE**	**COURSE TITLE**	**TEACHING SCHEDULE**			**CREDITS**	**Total Hours**
			L	**T**	**P**		
1	BSPH101A	MATHEMATICAL PHYSICS-I	4	0	0	4	4
2	BSPH151A	MATHEMATICAL PHYSICS-I LAB	0	0	4	2	4
3	BSPH102A	ELECTRICITY AND MAGNETISM	4	0	0	4	4
4	BSPH152A	ELECTRICITY AND MAGNETISM LAB	0	0	4	2	4
5	BSPH103A	MECHANICS	4	0	0	4	4
6	BSPH153A	MECHANICS LAB	0	0	4	2	4
7	BSPH106A	ELECTRICAL CIRCUITS AND NETWORK SKILLS	2	2	0	4	4
8		GENERIC ELECTIVE -II	4	2	0	6	4
TOTAL						**28**	**32**

	ODD SEMESTER							
SECOND	1	BSPH201A	MATHEMATICAL PHYSICS-II	4	0	0	4	4
	2	BSPH251A	MATHEMATICAL PHYSICS-II LAB	0	0	4	2	4
	3	BSPH203A	THERMAL PHYSICS	4	0	0	4	4
	4	BSPH253A	THERMAL PHYSICS LAB	0	0	4	2	4
	5	BSPH205A	DIGITAL SYSTEMS AND APPLICATIONS	4	0	0	4	4
	6	BSPH255A	DIGITAL SYSTEMS AND APPLICATIONS LAB	0	0	4	2	4
	7		GENERAL ELECTIVE -III	4	0	4	6	8
	TOTAL						**24**	**32**

EVEN SEMESTER							
1	BSPH202A	MATHEMATICAL PHYSICS-III	4	0	0	4	4
2	BSPH252A	MATHEMATICAL PHYSICS-III LAB	0	0	4	2	4
3	BSPH204A	ELEMENTS OF MODERN PHYSICS	4	0	0	4	4
4	BSPH254A	ELEMENTS OF MODERN PHYSICS LAB	0	0	4	2	4
5	BSPH104A	WAVES AND OPTICS	4	0	0	4	4
6	BSPH154A	WAVES AND OPTICS LAB	0	0	4	2	4
7		GENERAL ELECTIVE -IV	4	0	4	6	8
TOTAL						**24**	**32**

ODD SEMESTER								
THIRD	1	BSPH301A	QUANTUM MECHANICS AND APPLICATIONS	4	0	0	4	4
	2	BSPH351A	QUANTUM MECHANICS AND APPLICATIONS LAB	0	0	4	2	4
	3	BSPH303A	SOLID STATE PHYSICS	4	0	0	4	4
	4	BSPH353A	SOLID STATE PHYSICS LAB	0	0	4	2	4
	5	BSPH305A	BASIC INSTRUMENTATION SKILLS	2	2		4	4
	6	BSPH307A	CLASSICAL DYNAMICS	5	1	0	6	6
	7	BSPH309A	NUCLEAR AND PARTICLE PHYSICS	5	1	0	6	6
			VALUE ADDED COURSE					
	TOTAL						**28**	**32**

EVEN SEMESTER							
1	BSPH302A	ELECTROMAGNETIC THEORY	4	0	0	4	4
2	BSPH352A	ELECTROMAGNETIC THEORY LAB	0	0	4	2	4
3	BSPH304A	STATISTICAL MECHANICS	4	0	0	4	4
4	BSPH354A	STATISTICAL MECHANICS LAB	0	0	4	2	4
5	BSPH306A	APPLIED OPTICS	2	2	0	4	4
6	BSPH308A	PHYSICS OF EARTH	5	1	0	6	6
7	BSPH356A	DISSERTATION	0	0	2	6	
TOTAL						**28**	**26**

Electives (Choose any one from each group)

GEC-I						
1	BSMA121A	CALCULUS	4	0	0	4
	BSMA171A	CALCULUS LAB	0	0	4	2
2	BSCH141A	ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS	4	0	0	4
	BSCH161A	ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS LAB	0	0	4	2
3	ANY OTHER FROM POOL OF UNIVERSITY					6

GEC-II						
1	BSMA124A	ORDINARY DIFFERENTIAL EQUATIONS	4	0	0	4
	BSMA174A	ORDINARY DIFFERENTIAL EQUATIONS LAB	0	0	4	2
2	BSCH142A	CHEMICAL ENERGETICS, EQUILIBRIA & FUNCTIONAL GROUP ORGANIC CHEMISTRY-I	4	0	0	4
	BSCH162A	CHEMICAL ENERGETICS, EQUILIBRIA & FUNCTIONAL GROUP ORGANIC CHEMISTRY-I LAB	0	0	4	2
3	ANY OTHER FROM POOL OF UNIVERSITY					6

GEC-III						
1	BSMA215A	PROBABILITY AND STATISTICS	4	0	0	4
	BSMA271A	PROBABILITY AND STATISTICS LAB	0	0	4	2
2	BSCH241A	SOLUTIONS, PHASE EQUILIBRIUM, CONDUCTANCE, ELECTROCHEMISTRY & FUNCTIONAL GROUP ORGANIC CHEMISTRY-II	4	0	0	4
	BSCH267A	SOLUTIONS, PHASE EQUILIBRIUM, CONDUCTANCE, ELECTROCHEMISTRY & FUNCTIONAL GROUP ORGANIC CHEMISTRY-II LAB	0	0	4	2
3	ANY OTHER FROM POOL OF UNIVERSITY					6
GEC-IV						
1	BSMA304A	LINEAR PROGRAMMING	4	0	0	4
	BSMA374A	LINEAR PROGRAMMING LAB	0	0	4	2
2	BSCH242A	GREEN CHEMISTRY: DESIGNING CHEMISTRY FOR HUMAN HEALTH AND ENVIRONMENT	4	0	0	4
	BSCH268A	GREEN CHEMISTRY: DESIGNING CHEMISTRY FOR HUMAN HEALTH AND ENVIRONMENT LAB	0	0	4	2
3	ANY OTHER FROM POOL OF UNIVERSITY					6

Total Credits [C] = 160

Student can choose two non credit courses (2 hours per week), one in odd semester and one in even semester during the entire duration of Programme from the pool of courses provided by the university.

Student can choose available MOOCs recommended by Dean Academics and approved by Vice Chancellor of K. R. Mangalam University, from the list of approved MOOCs by SWAYAM Board in each semester.

7. Syllabus of B.Sc. (Hons.) Physics

SEMESTER-I

		L	T	P	C
BSPH101A	**MATHEMATICAL PHYSICS-I**	**4**	**0**	**0**	**4**

Objective:

1. To make them learn about the calculus and its applications.
2. To enable them to use vector calculus for different applications.
3. To give knowledge of vector differentiation, integration.
4. To impart knowledge about orthogonal curvilinear coordinate, probability and Dirac delta function and its properties.

Course Learning Outcomes

1. Apply concepts of calculus in solving problems of interest to physicists.
2. Better understand vector calculus and its applications.
3. Understand use of vector differentiation and integration.
4. Solve equations encountered in Physics and Engineering.

Course Content

Calculus:

Recapitulation: Limits, continuity, average and instantaneous quantities, differentiation. Plotting functions, Intuitive ideas of continuous, differentiable, etc. functions and plotting of curves. Approximation: Taylor and binomial series (statements only). (2 Lectures)

First Order and Second Order Differential equations: First Order Differential Equations and Integrating Factor. Homogeneous Equations with constant coefficients. Wronskian and general solution. Statement of existence and Uniqueness Theorem for Initial Value Problems. Particular Integral. (13 Lectures)

Calculus of functions of more than one variable: Partial derivatives, exact and inexact differentials. Integrating factor, with simple illustration. Constrained Maximization using Lagrange Multipliers. (6 Lectures)

Vector Calculus:

Recapitulation of vectors: Properties of vectors under rotations. Scalar product and its invariance under rotations. Vector product, Scalar triple product and their interpretation in terms of area and volume respectively. Scalar and Vector fields. (5 Lectures)

Vector Differentiation: Directional derivatives and normal derivative. Gradient of a scalar field and its geometrical interpretation. Divergence and curl of a vector field. Del and Laplacian operators. Vector identities. (8 Lectures)

Vector Integration: Ordinary Integrals of Vectors. Multiple integrals, Jacobian. Notion of infinitesimal line, surface and volume elements. Line, surface and volume integrals of Vector fields. Flux of a vector field. Gauss' divergence theorem, Green's and Stokes Theorems and their applications (no rigorous proofs). (14 Lectures)

Orthogonal Curvilinear Coordinates:

Orthogonal Curvilinear Coordinates. Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and Cylindrical Coordinate Systems. (6 Lectures)

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 hypothesi testing. (4 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. (2 Lectures)

Reference Books:

- Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris, 2013, 7th Edn., Elsevier.
- An introduction to ordinary differential equations, E.A. Coddington, 2009, PHI learning
- Differential Equations, George F. Simmons, 2007, McGraw Hill.
- Mathematical Tools for Physics, James Nearing, 2010, Dover Publications.
- Mathematical methods for Scientists and Engineers, D.A. McQuarrie, 2003, Viva Book
- Advanced Engineering Mathematics, D.G. Zill and W.S. Wright, 5 Ed., 2012, Jones and Bartlett Learning
- Mathematical Physics, Goswami, 1st edition, Cengage Learning
- Engineering Mathematics, S.Pal and S.C. Bhunia, 2015, Oxford University Press
- Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.
- Essential Mathematical Methods, K.F.Riley & M.P.Hobson, 2011, Cambridge Univ. Press.
- Mathematical Physics, H.K. Dass and R. Verma, S. Chand & Company.

BSPH151A	MATHEMATICAL PHYSICS-I LAB	L	T	P	C
		0	0	4	2

Course Objectives:

- Highlights the use of computational methods to solve physical problems
- Evaluation done not on the programming but on the basis of formulating the problem
- Aim at teaching students to construct the computational problem to be solved
- Students can use any one operating system Linux or Microsoft Windows

Course Learning Outcomes:

- On completion of this course, the students will be able to
- Acquire knowledge about the computer architecture and organization.
- To use the computational methods to solve physical problems.
- Understand errors and errors analysis.
- Use concepts to solve differential equations and other problems in physics and engineering.

Course Content

Topics	Description with Applications
Introduction and Overview	Computer architecture and organization, memory and Input/output devices
Basics of scientific computing	Binary and decimal arithmetic, Floating point numbers, algorithms, Sequence, Selection and Repetition, single and double precision arithmetic, underflow &overflow- emphasize the importance of making equations in terms of dimensionless variables, Iterative methods
Errors and error Analysis	Truncation and round off errors, Absolute and relative errors, Floating point computations.
Review of C & C++ Programming fundamentals	Introduction to Programming, constants, variables and data types, operators and Expressions, I/O statements, scanf and printf,

	c in and c out, Manipulators for data formatting, Control statements (decision making and looping statements) (If-statement. If-else Statement. Nested if Structure. Else-if Statement. Ternary Operator. Goto Statement. Switch Statement. Unconditional and Conditional Looping. While Loop. Do-While Loop. FOR Loop. Break and Continue Statements. Nested Loops), Arrays (1D & 2D) and strings, user defined functions, Structures and Unions, Idea of classes and objects
Programs:	Sum & average of a list of numbers, largest of a given list of numbers and its location in the list, sorting of numbers in ascending descending order, Binary search
Random number generation	Area of circle, area of square, volume of sphere, value of pi (π)
Solution of Algebraic and Transcendental equations by Bisection, Newton Raphsonand Secant methods	Solution of linear and quadratic equation, solving.. tan . ; . . . . in optics
Interpolation by Newton Gregory Forward and Backward difference formula, Error estimation of linear interpolation	Evaluation of trigonometric functions e.g. sin ¦È, cos ¦È, tan ¦È, etc.
Numerical differentiation (Forward and Backward difference formula) and Integration (Trapezoidal and Simpson rules), Monte Carlo method	Given Position with equidistant time data to calculate velocity and acceleration and vice versa. Find the area of B-H Hysteresis loop
Solution of Ordinary Differential Equations (ODE) First order Differential equation Euler, modified Euler and Runge-Kutta (RK) second and fourth order methods	First order differential equation . Radioactive decay . Current in RC, LC circuits with DC source . Newton¡¯s law of cooling . Classical equations of motion Attempt following problems using RK 4 order method: . Solve the coupled differential equations.... .. . . 3 ; .... for four initial conditions x(0) = 0, y(0) = -1, -2, -3, -4. Plot

	x vs y for each of the four initial conditions on the same screen for 0 ¡Ü t ¡Ü 15 The differential equation describing the motion of a pendulum is .... The pendulum is released from rest at an angular displacement ¦Á, i.e. ..0. . . and...0. .0. Solve the equation for ¦Á = 0.1, 0.5 and 1.0 and plot . as a function of time in the range 0 ¡Ü t¡Ü 8¦Ð. Also plot the analytic solution valid for small ....

Referred Books:

- Introduction to Numerical Analysis, S.S. Sastry, 5th Edn. , 2012, PHI Learning Pvt. Ltd.
- Schaum's Outline of Programming with C++. J. Hubbard, 2000, McGraw-Hill Pub.
- Numerical Recipes in C: The Art of Scientific Computing, W.H. Pressetal, 3rd Edn. , 2007, Cambridge University Press.
- A first course in Numerical Methods, U.M. Ascher & C. Greif, 2012, PHI Learning.
- Elementary Numerical Analysis, K.E. Atkinson, 3 r d E d n . , 2 0 0 7 , Wiley India Edition.
- Numerical Methods for Scientists & Engineers, R.W. Hamming, 1973, Courier Dover Pub.
- An Introduction to computational Physics, T.Pang, 2nd Edn. , 2006,Cambridge Univ. Press
- Computational Physics, Darren Walker, 1st Edn., 2015, Scientific International Pvt. Ltd.

BSPH103A	MECHANICS	L	T	P	C
		4	0	0	4

Course Objectives:

1. To acquire the knowledge of fundamentals of motion of objects, work, energy and collisions
2. To understand the concepts of rotational dynamics, elasticity and fluid motion.
3. To gain insight to the theory of gravitation and oscillations.
4. To have an insight about non-inertial systems and Special Theory of Relativity.

Course Learning Outcomes:

1. Better understand the laws of physics governing the motion of physical objects and relationship between force, work and energy.
2. Comprehend the concept of rotational motion of objects, elastic properties of the materials and motion of fluids.
3. Have an understanding of motion under gravitational force of attraction and simple harmonic motion.
4. Gain deeper understanding of Special Theory of Relativity, Lorentz Transformation, Mass energy transformations.

Course Content

Fundamentals of Dynamics: Reference frames. Inertial frames; Review of Newton's Laws of Motion. Galilean transformations; Galilean invariance. Momentum of variable-mass system: motion of rocket. Motion of a projectile in Uniform gravitational field Dynamics of a system of particles. Centre of Mass. Principle of conservation of momentum. Impulse. (6 Lectures)

Work and Energy: Work and Kinetic Energy Theorem. Conservative and non-conservative forces. Potential Energy. Energy diagram. Stable and unstable equilibrium. Elastic potential energy. Force as gradient of potential energy. Work & Potential energy. Work done by nonconservative forces. Law of conservation of Energy. (4 Lectures)

Collisions: Elastic and inelastic collisions between particles. Centre of Mass and Laboratory frames. (3 Lectures)

Rotational Dynamics: Angular momentum of a particle and system of particles.Torque. Principle of conservation of angular momentum. Rotation about a fixed axis. Moment of Inertia. Calculation of moment of inertia for rectangular, cylindrical and spherical bodies. Kinetic energy of rotation. Motion involving both translation and rotation. (12 Lectures)

Elasticity: Relation between Elastic constants. Twisting torque on a Cylinder or Wire. (3 Lectures)

Fluid Motion: Kinematics of Moving Fluids: Poiseuille's Equation for Flow of a Liquid through a Capillary Tube. (2 Lectures)

Gravitation and Central Force Motion: Law of gravitation. Gravitational potential energy. Inertial and gravitational mass. Potential and field due to spherical shell and solid sphere. (3 Lectures)
Motion of a particle under a central force field. Two-body problem and its reduction to one-body problem and its solution. The energy equation and energy diagram. Kepler's Laws. Satellite in circular orbit and applications. Geosynchronous orbits. Weightlessness. Basic idea of global positioning system (GPS). (6 Lectures)

Oscillations: SHM: Simple Harmonic Oscillations. Differential equation of SHM and its solution. Kinetic energy, potential energy, total energy and their time-average values. Damped oscillation. Forced oscillations: Transient and steady states; Resonance, sharpness of resonance; power dissipation and Quality Factor. (7 Lectures)
Non-Inertial Systems: Non-inertial frames and fictitious forces. Uniformly rotating frame. Laws of Physics in rotating coordinate systems. Centrifugal force. Coriolis force and its applications. Components of Velocity and Acceleration in Cylindrical and Spherical Coordinate Systems. (4 Lectures)

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. (10 Lectures)

Reference Books:

- An introduction to mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw-Hill.
- Mechanics, Berkeley Physics, vol.1, C.Kittel, W.Knight, et.al. 2007, Tata McGraw-Hill.
- Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley.
- Analytical Mechanics, G.R. Fowles and G.L. Cassiday. 2005, Cengage Learning
- Feynman Lectures, Vol. I, R.P.Feynman, R.B.Leighton, M.Sands, 2008, Pearson Education
- Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.

Additional Books for Reference

- Mechanics, D.S. Mathur, S. Chand and Company Limited, 2000
- University Physics. F.W Sears, M.W Zemansky, H.D Young 13/e, 1986, Addison Wesley
- Physics for scientists and Engineers with Modern Phys., J.W. Jewett, R.A. Serway, 2010,
- Cengage Learning
- Theoretical Mechanics, M.R. Spiegel, 2006, Tata McGraw Hill.

		L	T	P	C
	MECHANICS LAB	**0**	**0**	**4**	**2**

Course Objectives:

1. Demonstration cum laboratory sessions on the concepts of mechanics such as moment of inertia, determination of ‘g’ and elastic constants of materials.
2. Sessions on the review of scientific laboratory report writing, and on experimental data analysis.
3. Expand and exercise the students’ physical intuition and thinking process through the experiments.
4. Interpretation of experimental data.

Course Learning Outcomes :

1. Acquire fundamental knowledge of laboratory instruments and their uses.
2. Better insight about data collection techniques.
3. Better understanding of data interpretation and error analysis..
4. Acquire knowledge about the techniques related data analysis and curve fitting.

Course Content

1. Measurements of length (or diameter) using vernier caliper, screw gauge and travelling microscope.
2. To study the random error in observations.
3. To determine the height of a building using a Sextant.
4. To study the Motion of Spring and calculate (a) Spring constant, (b) g and (c) Modulus of rigidity.
5. To determine the Moment of Inertia of a Flywheel.
6. To determine g and velocity for a freely falling body using Digital Timing Technique
7. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).
8. To determine the Young's Modulus of a Wire by Optical Lever Method.
9. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
10. To determine the elastic Constants of a wire by Searle's method.
11. To determine the value of g using Bar Pendulum.
12. To determine the value of g using Kater's Pendulum.

Reference Books:

- Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Edn, 2011, Kitab Mahal
- Engineering Practical Physics, S.Panigrahi & B.Mallick,2015, Cengage Learning India Pvt.Ltd.
- Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University Press.

BSPH105A	PHYSICS WORKSHOP SKILL	L	T	P	C
		2	2	0	4

Course Objectives:

1. To make them learn about the different measuring instruments.
2. To enable them to use mechanical skill for development of new tools.
3. To give knowledge of soldering process.
4. To impart knowledge about gear systems, lever and pulley.

Course Learning Outcomes:

1. Apply concepts of measuring tools in solving problems of interest to physicists.
2. Better understand mechanical skill and its applications.
3. Understand use of electrical and electronics skill.
4. Solve equations encountered in Physics and Engineering.

Course Content

Introduction: Measuring units. conversion to SI and CGS. Familiarization with meterscale, Vernier caliper, Screw gauge and their utility. 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)

Mechanical Skill: Concept of workshop practice. Overview of manufacturing methods: casting, foundry, machining, forming and welding. Types of welding joints and welding defects. Common materials used for manufacturing like steel, copper, iron, metal sheets, composites and alloy, wood. Concept of machine processing, introduction to common machine tools like lathe, shaper, drilling, milling and surface machines. Cutting tools, lubricating oils. Cutting of a metal sheet using blade. Smoothening of cutting edge of sheet using file. Drilling of holes of different diameter in metal sheet and wooden block. Use of bench vice and tools for fitting. Make funnel using metal sheet. (10 Lectures)

Electrical and Electronic Skill: Use of Multimeter. Soldering of electrical circuitshaving 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.(10 Lectures)

Introduction to prime movers: Mechanism, gear system, wheel, Fixing of gears withmotor axel. Lever mechanism, Lifting of heavy weight using lever. braking systems, pulleys, working principle of power generation systems. Demonstration of pulley experiment. (6 Lectures)

Reference Books:

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

BSCH125A	ENVIORNMENTAL STUDIES	L	T	P	C
		3	0	0	3

Course Objectives:

1. To aware the students about the environment.
2. To learn the students concepts and methods from ecological and physical sciences and their application in environmental problem solving.
3. To think across and beyond existing disciplinary boundaries, mindful of the diverse forms of knowledge and experience that arise from human interactions with the world around them.
4. communicate clearly and competently matters of environmental concern and understanding to a variety of audiences in appropriate forms.

Course Learning Outcomes:

1. To comprehend and become responsive regarding environmental issues.
2. Acquire the techniques to protect our mother earth, as without a clean, healthy, aesthetically beautiful, safe and secure environment no specie can survive and sustain.
3. Enable the students to discuss their concern at national and international level with respect to formulate protection acts and sustainable developments policies.
4. To know that the rapid industrialization, crazy consumerism and over-exploitation of natural resources have resulted in degradation of earth at all levels.
5. Become consciousness about healthy and safe environment.

Course Content

Environment and Natural Resources: Multidisciplinary nature of environmental studies; Scope and importance; Concept of sustainability and sustainable development

Land resources: land use change; Land degradation, soil erosion and desertification.

Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations.

Water: Use and over-exploitation of surface and ground water, floods, droughts, conflicts over water (international & inter-state).

Energy resources: Renewable and non- renewable energy sources, use of alternate energy sources, growing energy needs, case studies.

Ecosystems and Biodiversity:

Ecosystem: Definition and Structure and function of ecosystem; Energy flow in an ecosystem: food chains, food webs and ecological succession.

Case studies of the following ecosystems:

a) Forest ecosystem

b) Grassland ecosystem

c) Desert ecosystem

d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Biological diversity: Levels of biological diversity; genetic, species and ecosystem diversity; Biogeographic zones of India; Biodiversity patterns and global biodiversity hot spots ; India as a mega-biodiversity nation; Endangered and endemic species of India; Threats to biodiversity: Habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions; Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity; Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value.

Environmental Pollution and Environmental Policies:

Environmental pollution: types, causes, effects and controls; Air, water, soil and noise pollution. Nuclear hazards and human health risks; Solid waste management: Control measures of urban and industrial waste; Pollution case studies.

Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture; Environment Laws: Environment Protection Act; Air (Prevention & Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act; Nature reserves, tribal populations and rights, and human wildlife conflicts in Indian context. International agreements: Montreal & Koyoto protocol and convention on biological diversity. Nature reserves, tribal population and rights, human wild life conflicts in Indian context.

Human Communities and the Environment and Field work:

Human population growth: Impacts on environment, human health and welfare; Resettlement and rehabilitation of project affected persons; case studies; Disaster management: floods, earthquake, cyclones and landslides; Environmental movements: Chipko, Silent valley, Bishnois of Rajasthan; Environmental ethics: Role of Indian and other religions and cultures in environmental conservation; Environmental communication and public awareness, case studies (e.g., CNG vehicles in Delhi).

Visit to an area to document environmental assets: river/ forest/ flora/fauna, etc.

Visit to a local polluted site-Urban/Rural/Industrial/Agricultural.

Study of common plants, insects, birds and basic principles of identification.

Study of simple ecosystems-pond, river, Delhi Ridge, etc.

SEMESTER-II

		L	T	P	C
BSPH102A	**ELECTRICITY AND MAGNETISM**	**4**	**0**	**0**	**4**

Course Objectives:

1. The abstraction from forces to fields using the examples of the electric and magnetic fields, with some applications
2. To learn how charges behave through electric circuits.
3. Consolidate the understanding of fundamental concepts in Electricity and Magnetism more rigorously as needed for further studies in physics, engineering and technology.
4. Expand and exercise the students' physical intuition and thinking process through the understanding of the theory and application of this knowledge to the solution of practical problems

Course Learning Outcomes :

1. Acquire fundamental knowledge of electrostatic interaction using Gauss Law and able to apply on physical systems.
2. Better insight about magnetic and dielectric behaviour of materials.
3. Better understanding of electrical circuits/theorems which enhances problem solving approach.
4. Develop the ability to correlates the daily life phenomenon to physics using mathematical tools.

Course Content

Electric Field and Electric Potential

Electric field: Electric field lines. Electric flux. Gauss' Law with applications to chargedistributions with spherical, cylindrical and planar symmetry. (6 Lectures)

Conservative nature of Electrostatic Field. Electrostatic Potential. Laplace's and Poisson equations. The Uniqueness Theorem. Potential and Electric Field of a dipole. Force and Torque on a dipole. (6 Lectures)

Electrostatic energy of system of charges. Electrostatic energy of a charged sphere. Conductors in an electrostatic Field. Surface charge and force on a conductor. Capacitance of a system of charged conductors. Parallel-plate capacitor. Capacitance of an isolated conductor. Method of Images and its application to: (1) Plane Infinite Sheet and (2) Sphere. (10 Lectures)

Dielectric Properties of Matter: Electric Field in matter. Polarization, Polarization Charges. Electrical Susceptibility and Dielectric Constant. Capacitor (parallel plate, spherical, cylindrical) filled with dielectric. Displacement vector D. Relations between E, P and D. Gauss' Law in dielectrics. (8 Lectures)

Magnetic Field: Magnetic force between current elements and definition of Magnetic Field B. Biot-Savart's Law and its simple applications: straight wire and circular loop. Current Loop as a Magnetic Dipole and its Dipole Moment (Analogy with Electric Dipole). Ampere's Circuital Law and its application to (1) Solenoid and (2) Toroid. Properties of B: curl and divergence. Vector Potential. Magnetic Force on (1) point charge (2) current carrying wire (3) between current elements. Torque on a current loop in a uniform Magnetic Field. (9 Lectures)

Magnetic Properties of Matter: Magnetization vector (M). Magnetic Intensity (H). Magnetic Susceptibility and permeability. Relation between B, H, M. Ferromagnetism. B-H curve and hysteresis. (4 Lectures)

Electromagnetic Induction: Faraday's Law. Lenz's Law. Self Inductance and Mutual Inductance. Reciprocity Theorem. Energy stored in a Magnetic Field. Introduction to Maxwell's Equations. Charge Conservation and Displacement current. (6 Lectures)

Electrical Circuits: AC Circuits: Kirchhoff's laws for AC circuits. Complex Reactance and Impedance. Series LCR Circuit: (1) Resonance, (2) Power Dissipation and (3) Quality Factor, and (4) Band Width. Parallel LCR Circuit. (4 Lectures)

Network theorems: Ideal Constant-voltage and Constant-current Sources. Network Theorems: Thevenin theorem, Norton theorem, Superposition theorem, Reciprocity theorem, Maximum Power Transfer theorem. Applications to dc circuits. (4 Lectures)

Ballistic Galvanometer: Torque on a current Loop. Ballistic Galvanometer: Current and Charge Sensitivity. Electromagnetic damping. Logarithmic damping. CDR. (3 Lectures)

Reference Books:

- Electricity, Magnetism & Electromagnetic Theory, S. Mahajan and Choudhury, 2012, Tata McGraw
- Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-Hill Education
- Introduction to Electrodynamics, D.J. Griffiths, 3rd Edn., 1998, Benjamin Cummings.
- Feynman Lectures Vol.2, R.P.Feynman, R.B.Leighton, M. Sands, 2008, Pearson Education
- Elements of Electromagnetics, M.N.O. Sadiku, 2010, Oxford University Press.
- Electricity and Magnetism, J.H.Fewkes & J.Yarwood. Vol. I, 1991, Oxford Univ. Press.

BSPH152A	ELECTRICITY AND MAGNETISM LAB	L	T	P	C
		0	0	4	2

Course Objectives:

1. Dedicated demonstration cum laboratory sessions on the construction, functioning and uses of different electrical bridge circuits, and electrical devices like the ballistic galvanometer. To learn how charges behave through electric circuits.
2. Sessions on the review of scientific laboratory report writing, and on experimental data analysis.
3. Expand and exercise the students' physical intuition and thinking process through the experiments.
4. Interpretation of experimental data

Course Learning Outcomes:

1. Acquire fundamental knowledge of laboratory instruments and their uses.
2. Better insight about data collection techniques.
3. Better understanding of data interpretation and error analysis..
4. Acquire knowledge about the techniques related data analysis and curve fitting.

Course Content

1. Use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, (d) Capacitances, and (e) Checking electrical fuses.
2. To study the characteristics of a series RC Circuit.
3. To determine an unknown Low Resistance using Potentiometer.
4. To determine an unknown Low Resistance using Carey Foster's Bridge.
5. To compare capacitances using De'Sauty's bridge.
6. Measurement of field strength B and its variation in a solenoid (determine dB/dx)
7. To verify the Thevenin and Norton theorems.
8. To verify the Superposition, and Maximum power transfer theorems.
9. To determine self inductance of a coil by Anderson's bridge.
10. To study response curve of a Series LCR circuit and determine its (a) Resonant frequency, (b) Impedance at resonance, (c) Quality factor Q, and (d) Band width.
11. To study the response curve of a parallel LCR circuit and determine its (a) Anti-resonant

frequency and (b) Quality factor Q.

12. Measurement of charge and current sensitivity and CDR of Ballistic Galvanometer
13. Determine a high resistance by leakage method using Ballistic Galvanometer.
14. To determine self-inductance of a coil by Rayleigh's method.
15. To determine the mutual inductance of two coils by Absolute method.

Reference Books:

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
- A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- Engineering Practical Physics, S.Panigrahi and B.Mallick, 2015, Cengage Learning.
- A Laboratory Manual of Physics for undergraduate classes, D.P.Khandelwal, 1985, Vani Pub.

BSPH104A	**WAVES AND OPTICS**	**L**	**T**	**P**	**C**
		4	**0**	**0**	**4**

Course Objectives:

1. To learn about the Simple Harmonic Oscillation and its solution
2. To understand the different wave's phenomenon
3. To understand the behaviour and properties of light
4. To acquire knowledge of interference diffraction, polarisation and Holography

Course Learning Outcomes:

1. Understand the characteristics of Simple Harmonic Motion.
2. Understand the role of the wave equation and appreciate the universal nature of wave motion in a range of physical systems.
3. Make them understand dual nature of light, light as a wave and its properties.
4. Acquire knowledge of various wave optics phenomena such as Interference, Diffraction, Polarisation and Holography.

Course Content

Superposition of Collinear Harmonic oscillations: Linearity and Superposition Principle. Superposition of two collinear oscillations having (1) equal frequencies and (2) different frequencies (Beats). Superposition of N collinear Harmonic Oscillations with (1) equal phase differences and (2) equal frequency differences. (5 Lectures)

Superposition of two perpendicular Harmonic Oscillations: Graphical and Analytical Methods. Lissajous Figures with equal an unequal frequency and their uses. (2 Lectures)

Wave Motion: Plane and Spherical Waves. Longitudinal and Transverse Waves. Plane Progressive (Travelling) Waves. Wave Equation. Particle and Wave Velocities. Differential Equation. Pressure of a Longitudinal Wave. Energy Transport. Intensity of Wave. Water Waves: Ripple and Gravity Waves. (4 Lectures)

Velocity of Waves: Velocity of Transverse Vibrations of Stretched Strings. Velocity of Longitudinal Waves in a Fluid in a Pipe. Newton's Formula for Velocity of Sound. Laplace's Correction. (6 Lectures)

Superposition of Two Harmonic Waves: Standing (Stationary) Waves in a String: Fixed and Free Ends. Analytical Treatment. Phase and Group Velocities. Changes with respect to Position and Time. Energy of Vibrating String. Transfer of Energy. Normal Modes of Stretched Strings. Plucked and Struck Strings. Melde's Experiment. Longitudinal Standing Waves and Normal Modes. Open and Closed Pipes. Superposition of N Harmonic Waves. (7 Lectures)

Wave Optics: Electromagnetic nature of light. Definition and properties of wave front. Huygens Principle. Temporal and Spatial Coherence. (3 Lectures)

Interference: Division of amplitude and wavefront. Young's double slit experiment. Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings: Measurement of wavelength and refractive index. (9 Lectures)

Interferometer: Michelson Interferometer-(1) Idea of form of fringes (No theoryrequired), (2) Determination of Wavelength, (3) Wavelength Difference, (4) Refractive Index, and (5) Visibility of Fringes. Fabry-Perot interferometer. (4 Lectures)

Diffraction: Kirchhoff's Integral Theorem, Fresnel-Kirchhoff's Integral formula. (Qualitative discussion only) (2 Lectures)

Fraunhofer diffraction: Single slit. Circular aperture, Resolving Power of a telescope. Double slit. Multiple slits. Diffraction grating. Resolving power of grating. (8 Lectures)

Fresnel Diffraction: Fresnel's Assumptions. Fresnel's Half-Period Zones for Plane Wave. Explanation of Rectilinear Propagation of Light. Theory of a Zone Plate: Multiple Foci of a Zone Plate. Fresnel's Integral, Fresnel diffraction pattern of a straight edge, a slit and a wire. (7 Lectures)

Holography: Principle of Holography. Recording and Reconstruction Method. Theory of Holography as Interference between two Plane Waves. Point source holograms. (3 Lectures)

Reference Books:

- Waves: Berkeley Physics Course, vol. 3, Francis Crawford, 2007, Tata McGraw-Hill.
- Fundamentals of Optics, F.A. Jenkins and H.E. White, 1981, McGraw-Hill
- Principles of Optics, Max Born and Emil Wolf, 7th Edn., 1999, Pergamon Press.
- Optics, Ajoy Ghatak, 2008, Tata McGraw Hill

- The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons.
- The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill.
- Fundamental of Optics, A. Kumar, H.R. Gulati and D.R. Khanna, 2011, R. Chand Publications.

BSPH154A	WAVES AND OPTICS LAB	L	T	P	C
		0	0	4	2

Course Objectives:

1. To learn about the experimental set ups related to various optical phenomena.
2. To learn the wave equation an its solution.
3. To understand the behaviour and properties of light.
4. To acquire knowledge of interference, diffraction, polarisation and Holography

Course Outcomes:

1. Get familiar with the laboratory instruments and their uses.
2. Understand the role of the wave equation and appreciate the universal nature of wave motion in a range of physical systems.
3. Expand and exercise the students' physical intuition and thinking process through the experiments.
4. Develop deep knowledge of optical phenomena i.e. Interference, Diffraction and Polarisation using hands on experiments.

Course Content

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1. To determine the frequency of an electric tuning fork by Melde's experiment and verify λ2 –T law.
2. To investigate the motion of coupled oscillators.
3. To study Lissajous Figures.
4. Familiarization with: Schuster`s focusing; determination of angle of prism.
5. To determine refractive index of the Material of a prism using sodium source.
6. To determine the dispersive power and Cauchy constants of the material of a prism using mercury source.
7. To determine the wavelength of sodium source using Michelson's interferometer.
8. To determine wavelength of sodium light using Fresnel Biprism.
9. To determine wavelength of sodium light using Newton's Rings.
10. To determine the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped Film.

11. To determine wavelength of (1) Na source and (2) spectral lines of Hg source using plane diffraction grating.
12. To determine dispersive power and resolving power of a plane diffraction grating.

Reference Books:

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
- A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- A Laboratory Manual of Physics for undergraduate classes, D.P.Khandelwal, 1985, Vani Pub.

		L	T	P	C
BSPH106A	**ELECTRICAL CIRCUITS AND NETWORK SKILLS**	**2**	**2**	**0**	**4**

Course Objectives:

1. To make them learn the basics of electricity, DC and AC Circuits.
2. To solve DC and AC circuits by KVL and KCL.
3. To make them understand the behaviour of RL, RC and RLC circuits.
4. To familiarise them with the working of Voltmeter, Ammeter and Multimeter.
5. To give knowledge of Electrical Machines such as Transformer, DC and AC Generator, DC Motor, Induction Motor, Synchronous Motor.
6. To enable them to recognise Electrical drawing symbols and to read an electrical drawing blueprint and ladder diagrams.
7. To give knowledge of electrical wiring, connectors and cables.

Course Outcomes:

1. Understand the difference between DC and AC circuits, Actice and Passive Components, Single and Three Phase Supply.
2. Learn the behavior of Main electric circuit elements and their combination i.e. RL, RC and RLC circuits.
3. Understand the basic construction and working mechanism of various electrical machines i.e. Transformer, Generators and Motors.
4. Read an electrical drawing and ladder diagram blueprint.
5. Troubleshoot any fault in an electrical circuit using Multimeter and other tools.

Course Content

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)

Electrical Drawing and Symbols: Drawing symbols. Blueprints. Reading Schematics. Ladder diagrams. Electrical Schematics. Power circuits. Control circuits. Reading of circuit schematics. Tracking the connections of elements and identify current flow and voltage drop. (4 Lectures) 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. (4 Lectures)
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)

Electrical Wiring: Different types of conductors and cables. Basics of wiring-Star anddelta connection. Voltage drop 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:

- A text book in Electrical Technology - B L Theraja - S Chand & Co.
- A text book of Electrical Technology - A K Theraja
- Performance and design of AC machines - M G Say ELBS Edn.

BSEL155AA	COMMUNICATION SKILLS	L	T	P	C
		4	0	0	4

Course Objectives:

1. Understand the basics of Grammar to improve written and oral communication skills.
2. Understand the correct form of English with proficiency
3. Improve student's personality and enhance their self-confidence.
4. Improve professional communication.
5. Enhance academic writing skills.

Course Learning Outcomes:

1. Understand the basics of Grammar to improve written and oral communication skills
2. Understand the correct form of English with proficiency
3. Improve student's personality and enhance their self-confidence
4. Improve professional communication
5. Enhance academic writing skills

Course Content

Introduction to Communication: Meaning, Forms & Types of Communication; Process of Communication; Principles of Effective Communication/7Cs, Barriers in Communication.

Emily Dickinson:"A Bird Came Down the Walk"

Essentials of Grammar: Parts of Speech: Noun, Pronoun, Adjective, Verb, Adverb, Preposition, Conjunction, Interjection; Using tenses; Articles; Types of sentences; Reported Speech; Punctuation.

Robert Frost: "Stopping by Woods"

Building Vocabulary: Word Formation (by adding suffixes and prefixes); Common Errors; Words Often Confused; One word substitution, Homonyms and Homophones; Antonyms &Synonyms, Phrasal Verbs, Idioms & Proverbs (25 each); Commonly used foreign words(15 in number);

O'Henry: *The Gift of Magi* Attitude, Self-esteem & Self-reliance; Public Speaking; Body Language: Posture, Gesture, Eye Contact, Facial Expressions; Presentation Skills/ Techniques.

Rabindranath Tagore: "My Prayer to Thee"

Personality Development: Etiquette & Manners; Leadership; Inter & intra personal skills;

Suggested Readings

Kumar, Sanjay and Pushplata. *Communication Skills*. Oxford University Press, 2015.

Mitra, Barun K. *Personality Development and Soft Skills*. Oxford University Press, 2012.

SEMESTER-III

The emphasis of the course is on applications in solving problems of interest to physicists. Students are to be examined on the basis of problems, seen and unseen.

BSPH201A	MATHEMATICAL PHYSICS-II	L	T	P	C
		4	0	0	4

Course Objectives:

1. To make them learn about the Fourier series expansion and its applications.
2. To enable them to use theory of errors on various types of data.
3. To give knowledge of special Functions such as Legendre, Bessel, Hermite and Laguerre and their properties.
4. To impart knowledge about various mathematical tools employed to study physics problems.

Course Outcomes:

1. Apply Fourier series expansion in solving problems of interest to physicists.
2. Better understand data interpretation and error analysis.
3. Understand use of special functions such as Legendre, Bessel, Hermite and Laguerre.
4. Solve partial differential equations encountered in Physics and Engineering.

Course Content

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. Application. Summing of Infinite Series. Term-by-Term differentiation and integration of Fourier Series. Parseval Identity. (10 Lectures)

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, Hermite and Laguerre Differential Equations. Properties of Legendre Polynomials: Rodrigues Formula, Generating Function, 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 (Jo(x) and J1(x)) and Orthogonality. (24 Lectures)
Some Special Integrals: Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions. Error Function (Probability Integral). (4 Lectures)

Theory of Errors: Systematic and Random Errors. Propagation of Errors. Normal Law of Errors. Standard and Probable Error. Least-squares fit. Error on the slope andintercept of a fitted line. (6 Lectures)

Partial Differential Equations: Solutions to partial differential equations, using separation of variables: Laplace's Equation in problems of rectangular, cylindrical and spherical symmetry. Wave equation and its solution for vibrational modes of a stretched string, rectangular and circular membranes. Diffusion Equation. (14 Lectures)

Reference Books:

- Mathematical Methods for Physicists: Arfken, Weber, 2005, Harris, Elsevier.
- Fourier Analysis by M.R. Spiegel, 2004, Tata McGraw-Hill.
- Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole.
- Differential Equations, George F. Simmons, 2006, Tata McGraw-Hill.
- Partial Differential Equations for Scientists & Engineers, S.J. Farlow, 1993, Dover Pub.
- Engineering Mathematics, S.Pal and S.C. Bhunia, 2015, Oxford University Press
- Mathematical methods for Scientists & Engineers, D.A. McQuarrie, 2003, Viva Books

BSPH251A	MATHEMATICAL PHYSICS-II LAB	L	T	P	C
		0	0	4	2

Course Objectives:

1. To make them familiar with Scilab/Matlab Simulation Softwares.
2. To learn Scilab/Matlab programs for Fourier series expansion and solution of differential equations.
3. Generation of Special functions using User defined functions in Scilab/Matlab.
4. To give knowledge of techniques of curve fitting and error analysis.

Course Learning Outcomes:

1. Acquire knowledge about the techniques related to data analysis and curve fitting.
2. To use the computational methods to solve physical problems.
3. Understand Scilab/Matlab programming to generate Special functions such as Legendre, Bessel, Hermite and Laguerre.
4. Use Scilab/Matlab programs for Fourier series expansion and solution of differential equations.

Topics	Description with Applications
Introduction to Numerical computation software Scilab	Introduction to Scilab, Advantages and disadvantages, Scilab environment, Command window, Figure window, Edit window, Variables and arrays, Initialising variables in Scilab, Multidimensional arrays, Subarray, Special values, Displaying output data, data file, Scalar and array operations, Hierarchy of operations, Built in Scilab functions, Introduction to plotting, 2D and 3D plotting (2), Branching Statements and program design, Relational & logical operators, the while loop, for loop, details of loop operations, break & continue statements, nested loops, logical arrays and vectorization (2) User defined functions, Introduction to Scilab functions, Variable passing in Scilab, optional arguments, preserving data between calls to a function, Complex and Character data, string function, Multidimensional arrays (2) an introduction to Scilab file processing, file opening and closing, Binary I/o functions, comparing binary and formatted functions, Numerical methods and developing the skills of writing a program (2).
Curve fitting, Least square fit, Goodness of fit, standard deviation	Ohms law to calculate R, Hooke's law to calculate spring Constant
Solution of Linear system of equations by Gauss elimination method and Gauss Seidal method. Diagonalization of matrices, Inverse of a matrix, Eigen vectors, eigen values problems	Solution of mesh equations of electric circuits (3 meshes) Solution of coupled spring mass systems (3 masses)
Generation of Special functions using User defined functions in Scilab	Generating and plotting Legendre Polynomials Generating and plotting Bessel function

Solution of ODE First order Differential equation Euler, modified Euler and Runge-Kutta second order methods Second order differential equation Fixed difference method Partial differential equations	First order differential equation Radioactive decay Current in RC, LC circuits with DC source Newton’s law of cooling Classical equations of motion Second order Differential Equation Harmonic oscillator (no friction) Damped Harmonic oscillator Over damped Critical damped Oscillatory Forced Harmonic oscillator Transient and Steady state solution Apply above to LCR circuits also

	Solve x□ □□□ □□□ □ 4x□1 □ x□ □□ □□ □ 2□1 □ x□ □ x□ with the boundary conditions at x = 1, y = □ □ e□, □□ □□ □ □ □ □ e□ □ 0.5, in the range 1 ≤ x ≤ 3. Plot y and □□ □□ against x in the given range on the same graph. Partial Differential Equation: □ Wave equation □ Heat equation □ Poisson equation □ Laplace equation
Using Scicos / xcos	□ Generating square wave, sine wave, saw tooth wave □ Solution to harmonic oscillator □ Study of beat phenomenon □ Phase space plots

Reference Books:

- Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and
- S. J. Bence, 3rd ed., 2006, Cambridge University Press
- Complex Variables, A.S. Fokas & M.J. Ablowitz, 8th Ed., 2011, Cambridge Univ. Press
- First course in complex analysis with applications, D.G. Zill and P.D. Shanahan,
- 1940, Jones & Bartlett
- Computational Physics, D.Walker, 1st Edn., 2015, Scientific International Pvt. Ltd.
- A Guide to MATLAB, B.R. Hunt, R.L. Lipsman, J.M. Rosenberg, 2014, 3rd
- Edn., Cambridge University Press
- Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and
- Engineering Applications: A.V. Wouwer, P. Saucez, C.V. Fernández. 2014 Springer
- Scilab by example: M. Affouf 2012, ISBN: 978-1479203444
- Scilab (A free software to Matlab): H.Ramchandran, A.S.Nair. 2011 S.Chand & Company
- Scilab Image Processing: Lambert M. Surhone. 2010 Betascript Publishing
- www.scilab.in/textbook_companion/generate_book/291

BSPH203A	THERMAL PHYSICS	L	T	P	C
		4	0	0	4

Course Objectives:

1. To acquire the knowledge of basic concepts of different laws of thermodynamics.
2. To understand the principles governing entropy and the associated theorems.
3. To comprehend the Maxwell thermodynamic relations.
4. To gain the insight of basic aspects of kinetic theory of gases, ideal gas and real gas behaviour and transport behaviour linked to ideal gases.

Course Learning Outcomes:

1. The students will be able to learn first, second laws of thermodynamics and their applications.
2. Enable students to know the significance of entropy and third law of thermodynamics and Carnot Cycle.
3. Understanding the thermodynamic potentials, their relations and their physical interpretations.
4. Understand the Maxwell-Boltzman distribution law, equipartition of energies, real gas equations, Van der Waal equation of state and the Joule-Thompson effect.

Course Content

Introduction to Thermodynamics

Zeroth and First Law of Thermodynamics: Extensive and intensive Thermodynamic Variables, Thermodynamic Equilibrium, Zeroth Law of Thermodynamics & Concept of Temperature, Concept of Work & Heat, State Functions, First Law of Thermodynamics and its differential form, Internal Energy, First Law & various processes, Applications of First Law: General Relation between CP and CV, Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion Co-efficient. (8 Lectures)

Second Law of Thermodynamics: Reversible and Irreversible process with examples. Conversion of Work into Heat and Heat into Work. Heat Engines. Carnot's Cycle, Carnot engine & efficiency. Refrigerator & coefficient of performance, 2nd Law of Thermodynamics: Kelvin- Planck and Clausius Statements and their Equivalence. Carnot's Theorem. Applications of Second Law of Thermodynamics: Thermodynamic Scale of Temperature and its Equivalence to Perfect Gas Scale. (10 Lectures)

Entropy: Concept of Entropy, Clausius Theorem. Clausius Inequality, Second Law of Thermodynamics in terms of Entropy. Entropy of a perfect gas. Principle of Increase of Entropy. Entropy Changes in Reversible and Irreversible processes with examples. Entropy of the Universe. Entropy Changes in Reversible and Irreversible Processes. Principle of Increase of Entropy. Temperature–Entropy diagrams for Carnot's Cycle. Third Law of Thermodynamics. Unattainability of Absolute Zero. (7 Lectures)

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. (7 Lectures)

Maxwell's Thermodynamic Relations: Derivations and applications of Maxwell'sRelations, Maxwell's Relations:(1) Clausius Clapeyron equation, (2) Values of Cp-Cv, (3) TdS Equations, (4) Joule-Kelvin coefficient for Ideal and Van der Waal Gases, (5) Energy equations, (6) Change of Temperature during Adiabatic Process. (7 Lectures)

Kinetic Theory of Gases

Distribution of Velocities: Maxwell-Boltzmann Law of Distribution of Velocities in anIdeal Gas and its Experimental Verification. Doppler Broadening of Spectral Lines and Stern's Experiment. Mean, RMS and Most Probable Speeds. Degrees of Freedom. Law of Equipartition of Energy (No proof required). Specific heats of Gases. (7 Lectures)

Molecular Collisions: Mean Free Path. Collision Probability. Estimates of Mean Free Path. Transport Phenomenon in Ideal Gases: (1) Viscosity, (2) Thermal Conductivity and (3) Diffusion. Brownian Motion and its Significance. (4 Lectures)

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

Reference Books:

- Heat and Thermodynamics, M.W. Zemansky, Richard Dittman, 1981, McGraw-Hill.
- A Treatise on Heat, Meghnad Saha, and B.N.Srivastava, 1958, Indian Press
- Thermal Physics, S. Garg, R. Bansal and Ghosh, 2nd Edition, 1993, Tata McGraw-Hill
- Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer.
- Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Sears & Salinger. 1988, Narosa.
- Concepts in Thermal Physics, S.J. Blundell and K.M. Blundell, 2nd Ed., 2012, Oxford University Press
- Thermal Physics, A. Kumar and S.P. Taneja, 2014, R. Chand Publications.
- Thermal Physics, B.K. Agrawal, Lok Bharti Publications.

BSPH253A	THERMAL PHYSICS LAB	L	T	P	C
		0	0	4	2

Course Objectives:

1. To acquire the skills of doing basic experiments in thermal physics with the right theoretical explanations of results.
2. To learn laboratory report writing.
3. To comprehend the experimental data analysis and interpretation of results.
4. To expand and exercise the students thinking process and team work through the experiments.

Course Learning Outcomes:

1. Acquire fundamental knowledge of laboratory instruments and their uses.
2. Enable students to measure calculate and analyze various thermodynamical quantities.
3. Develop experimental skills.
4. To identify and quantify the errors involved.

Course Content

1. To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow
method.
2. To determine the Coefficient of Thermal Conductivity of Cu by Searle's Apparatus.
3. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method.
4. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton's disc method.
5. To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT).
6. To study the variation of Thermo-Emf of a Thermocouple with Difference of Temperature of its Two Junctions.
7. To calibrate a thermocouple to measure temperature in a specified Range using
   (1) Null Method, (2) Direct measurement using Op-Amp difference amplifier and to determine Neutral Temperature.

Reference Books:

- Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House
- A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- A Laboratory Manual of Physics for undergraduate classes,D.P.Khandelwal,1985, Vani Pub.

BSPH205A	DIGITAL SYSTEMS AND APPLICATIONS	L	T	P	C
		4	0	0	4

Course Objectives:

1. To acquire knowledge of Number system
2. Understanding the integrated and digital circuits
3. Better understanding of Boolean algebra and Data processing circuits
4. Better understanding of Flip flops ,registers and counter.

Course Learning Outcomes:

1. Understand the number system,which is the base of digital electronics.
2. Enhance deep insight of Boolean mathematics and how to simplify logical expressions.
3. Get knowledge about cobinatinal logic circuits
4. Get Better understanding of sequential logic circuits which are beneficial in their day to day life.

Course Content

Introduction to CRO: Block Diagram of CRO. Electron Gun, Deflection System and Time Base. Deflection Sensitivity. Applications of CRO: (1) Study of Waveform, (2) Measurement of Voltage, Current, Frequency, and Phase Difference. (3 Lectures)

Integrated Circuits (Qualitative treatment only): Active & Passive components.Discrete components. Wafer. Chip. Advantages and drawbacks of ICs. Scale of integration: SSI, MSI, LSI and VLSI (basic idea and definitions only). Classification ofICs. Examples of Linear and Digital ICs. (3 Lectures)

Digital Circuits: Difference between Analog and 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. (6 Lectures)

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. (6 Lectures)

Data processing circuits: Basic idea of Multiplexers, De-multiplexers, Decoders, Encoders. (4 Lectures)

Arithmetic Circuits: Binary Addition. Binary Subtraction using 2's Complement. Half and Full Adders. Half & Full Subtractors, 4-bit binary Adder/Subtractor. (5 Lectures)

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 JKFlip-Flop. (6 Lectures)

Timers: IC 555: block diagram and applications: Astable multivibrator and Monostable multivibrator. (3 Lectures)

Shift registers: Serial-in-Serial-out, Serial-in-Parallel-out, Parallel-in-Serial-out and Parallelin- Parallel-out Shift Registers (only up to 4 bits). (2 Lectures)

Counters (4 bits): Ring Counter. Asynchronous counters, Decade Counter. Synchronous Counter. (4 Lectures)

Computer Organization: Input/output Devices. Data storage (idea of RAM and ROM).Computer memory. Memory organization & addressing. Memory Interfacing. Memory Map. (6 Lectures)

Intel 8085 Microprocessor Architecture: Main features of 8085. Block diagram. Components. Pin-out diagram. Buses. Registers. ALU. Memory. Stack memory. Timing And Control circuitry. Timing states. Instruction cycle, Timing diagram of MOV and MVI. (8 Lectures)

Introduction to Assembly Language: 1 byte, 2 byte & 3 byte instructions. (4 Lectures)

Reference Books:

- Digital Principles and Applications, A.P. Malvino, D.P.Leach and Saha, 7th Ed., 2011, Tata McGraw
- Fundamentals of Digital Circuits, Anand Kumar, 2nd Edn, 2009, PHI Learning Pvt. Ltd.
- Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
- Digital Electronics G K Kharate ,2010, Oxford University Press
- Digital Systems: Principles & Applications, R.J.Tocci, N.S.Widmer, 2001, PHI Learning
- Logic circuit design, Shimon P. Vingron, 2012, Springer.
- Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.
- Digital Electronics, S.K. Mandal, 2010, 1st edition, McGraw Hill
- Microprocessor Architecture Programming & applications with 8085, 2002, R.S. Goankar, Prentice Hall.

<table>
<tr><td rowspan="2">BSPH255A</td><td rowspan="2">DIGITAL SYSTEMS AND APPLICATIONS LAB</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
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Course Objectives:

1. To acquire knowledge of Number system
2. Understanding the integrated and digital circuits
3. Better understanding of Boolean algebra and Data processing circuits
4. Better understanding of Flip flops ,registers and counter.

Course Learning Outcomes:

1. Get the knowledge of designing the gates.
2. Enhance deep insight of Boolean mathematics and how to simplify logica expressions.
3. Get the experimental knowledge about combinational logic system
4. Get Better understanding of registers and counters. How they are beneficial in day to day life.

Course Content

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. UGC Document on LOCF Physics 146
7. To convert a Boolean expression into logic circuit and design it using logic gate ICs.
8. To minimize a given logic circuit.
9. Half Adder, Full Adder and 4-bit binary Adder.
10. Half Subtractor, Full Subtractor, Adder-Subtractor using Full Adder I.C.
11. To build Flip-Flop (RS, Clocked RS, D-type and JK) circuits using NAND gates.
12. To build JK Master-slave flip-flop using Flip-Flop ICs
13. To build a 4-bit Counter using D-type/JK Flip-Flop ICs and study timing diagram.
14. To make a 4-bit Shift Register (serial and parallel) using D-type/JK Flip-Flop ICs.
15. To design an astable multivibrator of given specifications using 555 Timer.
16. To design a monostable multivibrator of given specifications using 555 Timer.
17. Write the following programs using 8085 Microprocessor
    a) Addition and subtraction of numbers using direct addressing mode
    b) Addition and subtraction of numbers using indirect addressing mode
    c) Multiplication by repeated addition.
    d) Division by repeated subtraction.
    e) Handling of 16-bit Numbers.
    f) Use of CALL and RETURN Instruction.
    g) Block data handling.
    h) Other programs (e.g. Parity Check, using interrupts, etc.).

Reference Books:

- Modern Digital Electronics, R.P. Jain, 4th Edition, 2010, Tata McGraw Hill.
- Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw Hill.
- Microprocessor Architecture Programming and applications with 8085, R.S. Goankar, 2002, Prentice Hall.
- Microprocessor 8085:Architecture, Programming and interfacing, A. Wadhwa, 2010, PHI Learning.

BSDM301A	DISASTER MANAGEMENT	L	T	P	C
		3	0	0	3

Course Objectives:

1. To create awareness about various types of disasters.
2. To educate the students about basic disaster management strategies and problem solving.
3. To examine disaster profile of our country and illustrates the role of governmental and non- governmental organizations in its effective management.
4. To acquaints students with the existing legal frame work for disaster management and understanding the appropriate rules and regulations.

Course Learning Outcomes:

1. To enable the students to know the difference between natural and man- made disaster
2. Acquire the knowledge related to disaster preparedness
3. To aware the student about recovery after disaster
4. To know the structure and functioning of disaster management framework of our country
5. To provide the knowledge about disaster management act

Course Content

Units I. Introduction to Disasters:
Concepts, and definitions (Disaster, Hazard, Vulnerability, Resilience, Risks)

Units II. Disasters: Classification, Causes, Impacts (including social, economic, political, environmental, health, psychosocial, etc.), Differential impacts- in terms of caste, class, gender, age, location, disability, Global trends in disasters, urban disasters, pandemics, complex emergencies,
Climate change

Units III. Approaches to Disaster Risk reduction:
Disaster cycle - its analysis, Phases, Culture of safety, prevention, mitigation and preparedness community based DRR, Structural- nonstructural measures, roles and responsibilities of- community, Panchayati Raj Institutions/Urban Local Bodies (PRIs/ULBs), states, Centre, and other stake-holders.

Units IV. Inter-relationship between Disasters and Development:
Factors affecting Vulnerabilities, differential impacts, impact of Development projects such as dams, embankments, changes in Land-use etc. Climate Change Adaptation. Relevance of indigenous knowledge, appropriate technology and local resources

Units V. Disaster Risk Management in India
Hazard and Vulnerability profile of India, Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management Institutional arrangements (Mitigation, Response and Preparedness, DM Act and Policy, Other related policies, plans, programmes and legislation)

Units VI. Project Work: (Field Work, Case Studies)
The project /fieldwork is meant for students to understand vulnerabilities and to work on reducing disaster risks and to build a culture of safety. Projects must be conceived creatively based on the geographic location and hazard profile of the region where the college is located.

A few ideas or suggestions are discussed below.
Several governmental initiatives require Urban Local Bodies (ULBs) and Panchayati Raj Institutions (PRIs) to be proactive in preparing DM Plans and community based disaster preparedness plans. Information on these would be available with the district Collector or Municipal Corporations. The scope for students to collaborate on these initiatives is immense.

Teachers may explore possibilities.
Teachers could ask students to explore and map Disaster prone areas, vulnerable sites, vulnerability of people (specific groups) and resources. The students along with teachers could work on ways of addressing these vulnerabilities, preparing plans in consultation with local administration or NGOs.

Students could conduct mock drills in schools, colleges or hospitals. They could also work on school safety, safety of college buildings) training in first aid.

Other examples could be- identifying how a large dam, road/ highway or an embankment or the location of an industry affects local environment and resources or how displacement of large sections of people creates severe vulnerabilities may be mapped by student project work.

Teaching Resources
A range of Films- documentaries and feature films related to disasters and their impacts and on vulnerabilities of people are available which a teacher could choose with care and screen. This could form a basis for classroom discussion.

Suggested Reading list:

Alexander David, Introduction in 'Confronting Catastrophe', Oxford University Press, 2000

Andharia J. Vulnerability in Disaster Discourse, JTCDM, Tata Institute of Social Sciences Working Paper no. 8, 2008

Blaikie, P, Cannon T, Davis I, Wisner B 1997. At Risk Natural Hazards, Peoples' Vulnerability and Disasters, Routledge.

Coppola P Damon, 2007. Introduction to International Disaster Management,

Carter, Nick 1991. Disaster Management: A Disaster Manager's Handbook. Asian Development Bank, Manila Philippines.

Cuny, F. 1983. Development and Disasters, Oxford University Press.

Document on World Summit on Sustainable Development 2002.

Govt. of India: Disaster Management Act 2005, Government of India, New Delhi.

Government of India, 2009. National Disaster Management Policy,

Gupta Anil K, Sreeja S. Nair. 2011 Environmental Knowledge for Disaster Risk Management, NIDM, New Delhi

Indian Journal of Social Work 2002. Special Issue on Psychosocial Aspects of Disasters, Volume 63, Issue 2, April.

Kapur, Anu & others, 2005: Disasters in India Studies of grim reality, Rawat Publishers, Jaipur

Kapur Anu 2010: Vulnerable India: A Geographical Study of Disasters, IIAS and Sage Publishers, New Delhi.

Parasuraman S, Acharya Niru 2000. Analysing forms of vulnerability in a disaster, The Indian Journal of Social Work, vol 61, issue 4, October

Pelting Mark, 2003 The Vulnerability of Cities: Natural Disaster and Social Resilience Earthscah publishers, London

Reducing risk of disasters in our communities, Disaster theory, Tearfund, 2006.

UNISDR, Natural Disasters and Sustainable Development: Understanding the links between Development, Environment and Natural Disasters, Background Paper No. 5. 2002.

IFRC,2005. World Disaster Report: Focus on Information in Disaster, pp. 182-225.

Publications of National Institute Of Disaster Management (NIDM) and National Disaster Management Authority (NDMA) including Various Guidelines for Disaster Management are available at:

NATIONAL INSTITUTE OF DISASTER MANAGEMENT,
(Ministry of Home Affairs, Government of India),
5-B, IIPA Campus, IP Estate, Mahatma Gandhi Marg,
New Delhi - 110002 (INDIA) , Tel. - 011-23702432, 23705583, 23766146
Telefax - 011-23702442, 23702446

Web sites and Web Resources:

NIDM Publications at http://nidm.gov.in- Official Website of National Institute of Disaster Management (NIDM), Ministry of Home Affairs, Government of India

http://cwc.gov.in

http://ekdrm.net

http://www.emdat.be

http://www.nws.noaa.gov
http://pubs.usgs.gov
http://nidm.gov.in, http://www.imd.gov.in

SEMESTER-IV

<table>
<tr><td rowspan="2">BSPH202A</td><td rowspan="2">MATHEMATICAL PHYSICS-III</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
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Course Objectives:

1. To make them learn about the complex numbers and their properties, functions of complex numbers and their properties such as analyticity, poles and residues.

2. To enable them to use residue theorem and its applications in evaluating definite Integrals.

3. To give knowledge of Fourier transform, Laplace Transform and their applications in real world problems.

4. To impart knowledge about various mathematical tools employed to study physics problems.

Course Learning Outcomes:

1. Understand Complex numbers and their properties.
2. Solve for singularities and residues of a complex function.
3. Evaluate definite integrals applying residue theorem.
4. Understand the use of Fourier transform in many applications for example Image processing.
5. Apply Laplace transform to solve ODE, PDE and other problems related to Physics and Engineering.

Course Content

Complex Analysis: Brief Revision of Complex Numbers and their GraphicalRepresentation. 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, branch cuts. Integration of a function of a complex variable. Cauchy's Inequality. Cauchy’s Integral formula. Simply and multiply connected region. Laurent and Taylor’s expansion. Residues and Residue Theorem. Application in solving Definite Integrals. (30 Lectures)

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)

Laplace Transforms: Laplace Transform (LT) of Elementary functions. Properties ofLTs: Change of Scale Theorem, Shifting Theorem. LTs of 1st and 2nd 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 2nd order Differential Equations: Damped Harmonic Oscillator, Simple Electrical Circuits, Coupled differential equations of 1st order. Solution of heat flow along infinite bar using Laplace transform. (15 Lectures)

Reference Books:

- Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence,3rd ed., 2006, Cambridge University Press
- Mathematics for Physicists, P. Dennery and A.Krzywicki, 1967, Dover Publications
- Complex Variables, A.S.Fokas & M.J.Ablowitz, 8th Ed., 2011, Cambridge Univ. Press
- Complex Variables, A.K. Kapoor, 2014, Cambridge Univ. Press
- Complex Variables and Applications, J.W. Brown & R.V. Churchill, 7th Ed. 2003, Tata McGraw-Hill
- First course in complex analysis with applications, D.G. Zill and P.D. Shanahan, 1940, Jones & Bartlett

BSPH252A	MATHEMATICAL PHYSICS-III LAB	L	T	P	C
		0	0	4	2

Course Objectives:

1. To make them familiar with Scilab/Matlab Simulation Softwares.
2. To learn Matlab programs for Fourier transform, the inverse Fourier transform and their applications in real world problems.
3. To learn Matlab programs for Laplace transform, the inverse Laplace transforms and their applications in solving problems related to Physics and Engineering.
4. To give knowledge of techniques of curve fitting and error analysis.

Course Learning Outcomes:

1. Acquire knowledge about the techniques related to data analysis and curve fitting.
2. Better understand data interpretation and error analysis.
3. To use the computational methods to solve physical problems.
4. Use Matlab programs to calculate Fourier transform of various functions and implementation of complex numbers.
5. Apply Laplace transform using Matlab to solve ODE, PDE and other problems related to Physics and Engineering.

Course Content

Scilab/C++ based simulations experiments based on Mathematical Physics problems like
1. Solve differential equations:
dy/dx = e-x with y = 0 for x = 0
dy/dx + e-xy = x2
d2y/dt2 + 2 dy/dt = -y
d2y/dt2 + e-tdy/dt = -y
2. Evaluate Dirac Delta Function:
3. Fourier Series:
Evaluate the Fourier coefficients of a given periodic function (square wave)
4. Frobenius method and Special functions:
Plot Pn(x), jv(x)
Show recursion relation
5. Calculation of error for each data point of observations recorded in experiments done in previous semesters (choose any two).
UGC Document on LOCF Physics 149
6. Calculation of least square fitting manually without giving weightage to error.
Confirmation of least square fitting of data through computer program.
7. Evaluation of trigonometric functions e.g. sin θ, Given Bessel's function at N points find its value at an intermediate point. Complex analysis: Integrate 1/(x2+2) numerically and check with computer integration.
8. Compute the nth roots of unity for n = 2, 3, and 4.
9. Find the two square roots of −5+12j.
10. Integral transform: FFT of
11. Solve Kirchoff's Current law for any node of an arbitrary circuit using Laplace's transform.
12. Solve Kirchoff's Voltage law for any loop of an arbitrary circuit using Laplace's transform.
13. Perform circuit analysis of a general LCR circuit using Laplace's transform.

Reference Books:

- Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3rd ed., 2006, Cambridge University Press
- Mathematics for Physicists, P. Dennery and A. Krzywicki, 1967, Dover Publications
- Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB:
- Scientific and Engineering Applications: A. Vande Wouwer, P. Saucez, C. V.
- Fernández. 2014 Springer ISBN: 978-3319067896
- A Guide to MATLAB, B.R. Hunt, R.L. Lipsman, J.M. Rosenberg, 2014, 3rd Edn., Cambridge University Press
- Scilab by example: M. Affouf, 2012. ISBN: 978-1479203444
- Scilab (A free software to Matlab): H.Ramchandran, A.S.Nair. 2011 S.Chand & Company

- Scilab Image Processing: Lambert M. Surhone. 2010 Betascript Publishing
- https://web.stanford.edu/~boyd/ee102/laplace_ckts.pdf
- ocw.nthu.edu.tw/ocw/upload/12/244/12handout.pdf

BSPH204A	ELEMENTS OF MODERN PHYSICS	L	T	P	C
		4	0	0	4

Couse Objectives:

1. Understand the structure of the atom
2. Explore the particle properties of waves
3. Examine the wave properties of particles.
4. Study nuclear transformations.

Course Learning Outcomes:

1. Understand the fundamental structure and behavior of atoms.
2. Comprehend the dual nature of particles
3. Analyze structure and properties of nucleus
4. Apply knowledge to nuclear transformations and reactions

Course Content

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. (14 Lectures)

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 an interaction. (5 Lectures)

Two slit interference experiment with photons, atoms and particles; linear superposition principle as a consequence; Matter waves and wave amplitude; Schrodinger equation for non-relativistic particles; Momentum and Energy operators; stationary states; physical interpretation of a wave function, probabilities and normalization; Probability and probability current densities in one dimension. (10 Lectures)

One dimensional infinitely rigid box- energy eigenvalues and eigenfunctions, normalization; Quantum dot as example; Quantum mechanical scattering and tunnelling in one dimensionacross a step potential & rectangular potential barrier. (10 Lectures)

Size and structure of atomic nucleus and its relation with atomic weight; Impossibility of an electron being in the nucleus as a consequence of the uncertainty principle. Nature of nuclear force, NZ graph, Liquid Drop model: semi-empirical mass formula and binding energy, Nuclear Shell Model and magic numbers. (6 Lectures)

Radioactivity: stability of the nucleus; Law of radioactive decay; Mean life and half-life; Alpha decay; Beta decay- energy released, spectrum and Pauli's prediction of neutrino; Gamma ray emission, energy-momentum conservation: electron-positron pair creation by gamma photons in the vicinity of a nucleus. (8 Lectures)

Fission and fusion- mass deficit, relativity and generation of energy; Fission - nature of fragments and emission of neutrons. Nuclear reactor: slow neutrons interacting with Uranium 235; Fusion and thermonuclear reactions driving stellar energy (brief qualitative discussions). (3 Lectures)

Lasers: Einstein's A and B coefficients. Metastable states. Spontaneous and Stimulated emissions. Optical Pumping and Population Inversion. Three-Level and Four-Level Lasers. Ruby Laser and He-Ne Laser. Basic lasing. (4 Lectures)

Reference Books:

- Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.
- Introduction to Modern Physics, Rich Meyer, Kennard, Coop, 2002, Tata McGraw Hill
- Introduction to Quantum Mechanics, David J. Griffith, 2005, Pearson Education.
- Physics for scientists and Engineers with Modern Physics, Jewett and Serway, 2010, Cengage Learning.
- Modern Physics, G.Kaur and G.R. Pickrell, 2014, McGraw Hill
- Quantum Mechanics: Theory & Applications, A.K.Ghatak & S.Lokanathan, 2004, Macmillan

Additional Books for Reference

- Modern Physics, J.R. Taylor, C.D. Zafiratos, M.A. Dubson, 2004, PHI Learning.
- Theory and Problems of Modern Physics, Schaum`s outline, R. Gautreau and W. Savin, 2nd Edn, Tata McGraw-Hill Publishing Co. Ltd.
- Quantum Physics, Berkeley Physics, Vol.4. E.H.Wichman, 1971, Tata McGraw-Hill Co.
- Basic ideas and concepts in Nuclear Physics, K.Heyde, 3rd Edn., Institute of Physics Pub.
- Six Ideas that Shaped Physics: Particle Behave like Waves, T.A.Moore, 2003, McGraw Hill
- Quantum Mechanics, R. Eisberg and R. Resnick, John Wiley & Sons.

BSPH254A	ELEMENTS OF MODERN PHYSICS LAB	L	T	P	C
		0	0	4	2

Course Objectives:

1. Develop a foundational understanding of quantum mechanics, emphasizing Planck's constant and the photoelectric effect through hands-on experiments.
2. Hone experimental skills to investigate the photoelectric effect, analyzing relationships between photo current, intensity, wavelength, and energy of photoelectrons.
3. Gain practical insight into electronic properties by determining the work function of a directly heated vacuum diode filament.
4. Develop competency in quantum measurements, calculating Planck's constant using LEDs of various colors and determining wavelengths in laser diffraction experiments.

Course Learning Outcomes:

1. Demonstrate applied mastery of quantum principles, showcasing proficiency in understanding and utilizing foundational concepts.
2. Showcase proficiency in analytically interpreting experimental outcomes related to the photoelectric effect and its parameters.
3. Acquire a deeper understanding of electronic structures by practically determining the work function of a directly heated vacuum diode filament.
4. Demonstrate expertise in conducting quantum experiments, showcasing the ability to measure Planck's constant and wavelengths using diverse experimental setups.

Course Content

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 photo-electrons 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 the wavelength of laser source using diffraction of single slit.
12. To determine the wavelength of laser source using diffraction of double slits.
13. To determine (1) wavelength and (2) angular spread of He-Ne laser using plane diffraction grating

Reference Books

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

BSPH206A	ANALOG SYSTEMS AND APPLICATIONS	L	T	P	C
		4	0	0	4

Course Objectives:

1. Characteristics and working of pn junction.
2. Two terminal devices: Rectifier diodes, Zener diode, photodiode etc
3. NPN and PNP transistors: Characteristics of different configurations, biasing, stabilization and their applications.
4. CE and two stage RC coupled transistor amplifier using h-parameter model of the transistor.
5. Designing of different types of oscillators and their stabilities.
6. Ideal and practical op-amps: Characteristics and applications.
7. In the laboratory course, the students will be able to study characteristics of various diodes and BJT. They will be able to design amplifiers, oscillators and DACs. Also different applications using Op-Amp will be designed.

Course Learning Outcomes:

1. Gain deeper understanding of semiconductors physics and related principle concepts.
2. Implementation of theoretical knowledge in practical applications.
3. Bridge basic physics to electronics applications.
4. Advance skills and capability for formulating and solving problems. Expand the analytical ability to solve circuit based designs.

Course Content

Semiconductor Diodes: P and N type semiconductors. Energy Level Diagram.Conductivity and Mobility, Concept of Drift velocity. PN Junction Fabrication (Simple Idea). 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 Mechanismin Forward and Reverse Biased Diode. (10 Lectures)

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, CEand 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)

Amplifiers: Transistor Biasing and Stabilization Circuits. Fixed Bias and VoltageDivider 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)

Sinusoidal Oscillators: Barkhausen's Criterion for self-sustained oscillations. RC Phaseshift oscillator, determination of Frequency. Hartley & Colpitts oscillators. (4 Lectures)

Operational Amplifiers (Black Box approach): Characteristics of an Ideal andPractical 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 crossingdetector (8) Wein bridge oscillator. (9 Lectures)

Conversion: Resistive network (Weighted and R-2R Ladder). Accuracy and Resolution. A/D Conversion (successive approximation) (3 Lectures)

Reference Books:

- Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
- Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.
- Solid State Electronic Devices, B.G.Streetman & S.K.Banerjee, 6th Edn.,2009, PHI Learning
- Electronic Devices & circuits, S.Salivahanan & N.S.Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill
- OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall
- Microelectronic circuits, A.S. Sedra, K.C. Smith, A.N. Chandorkar, 2014, 6th Edn., Oxford University Press.
- Electronic circuits: Handbook of design & applications, U.Tietze, C.Schenk,2008, Springer

- Semiconductor Devices: Physics and Technology, S.M. Sze, 2nd Ed., 2002, Wiley India
- Microelectronic Circuits, M.H. Rashid, 2nd Edition, Cengage Learning
- Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India

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BSPH256A	ANALOG SYSTEMS AND APPLICATIONS LAB	L	T	P	C
		0	0	4	2

Course Objectives:

1. Dedicated demonstration cum laboratory sessions on the construction, functioning and uses of different electrical bridge circuits, and electrical devices like the ballistic galvanometer. To learn how charges behave through electric circuits.
2. Sessions on the review of scientific laboratory report writing, and on experimental data analysis.
3. Expand and exercise the students' physical intuition and thinking process through the experiments.
4. Interpretation of experimental data

Course Learning Outcomes:

1. Acquire fundamental knowledge of laboratory instruments and their uses.
2. Better insight about data collection techniques.
3. Better understanding of data interpretation and error analysis..
4. Acquire knowledge about the techniques related data analysis and curve fitting.

Course Content

1. To study V-I characteristics of PN junction diode, and Light emitting diode.
2. To study the V-I characteristics of a Zener diode and its use as voltage regulator.
3. Study of V-I & power curves of solar cells, and find maximum power point & efficiency.
4. To study the characteristics of a Bipolar Junction Transistor in CE configuration.
5. To study the various biasing configurations of BJT for normal class A operation.
6. To design a CE transistor amplifier of a given gain (mid-gain) using voltage divider bias.
7. To study the frequency response of voltage gain of a RC-coupled transistor amplifier.
8. To design a Wien bridge oscillator for given frequency using an op-amp.
9. To design a phase shift oscillator of given specifications using BJT.
10. To study the Colpitt`s oscillator.
11. To design a digital to analog converter (DAC) of given specifications.
12. To study the analog to digital convertor (ADC) IC.
13. To design an inverting amplifier using Op-amp (741,351) for dc voltage of given gain
14. To design inverting amplifier using Op-amp (741,351) and study its frequency response
15. To design non-inverting amplifier using Op-amp (741,351) & study its frequency response

16. To study the zero-crossing detector and comparator
17. To add two dc voltages using Op-amp in inverting and non-inverting mode
18. To design a precision Differential amplifier of given I/O specification using Op-amp.
19. To investigate the use of an op-amp as an Integrator.
20. To investigate the use of an op-amp as a Differentiator.
21. To design a circuit to simulate the solution of a 1st/2nd order differential equation.

Reference Books:

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

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SEMESTER-V

		L	T	P	C
BSPH301A	**QUANTUM MECHANICS AND APPLICATIONS**	**4**	**0**	**0**	**4**

Course Objectives:

1. Acquire knowledge of time independent perturbed systems using Schrödinger's equation.
2. Know about the mechanism related to electronic transitions using time independent perturbed systems.
3. Explanation of physical significance of phenomenon of scattering quantum mechanically.
4. Deep insight about the co-relationship between relativity and quantum mechanics.

Course Learning Outcomes:

1. Better understanding of perturbed quantum mechanical systems and their applications
2. Formulation of time-dependent perturbed systems and their correlation between experimental phenomenons.
3. Comprehend the concepts of quantum mechanical treatment of scattering and applications.
4. Gain deeper understanding of relativistic quantum mechanical systems and their reduction in nonrelativistic form.

Course Content

Time dependent Schrodinger equation: Time dependent Schrodinger equation anddynamical 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 valuesof position and momentum. Wave Function of a Free Particle. (6 Lectures)

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- continuity of wavefunction, boundary condition and emergence of discrete energy levels; application to one-dimensional problem-square well potential; Quantum mechanics of simple harmonic oscillator-energy levels and energy eigenfunctions using Frobenius method; Hermitepolynomials; ground state, zero-point energy & uncertainty principle. (12 Lectures)

Quantum theory of hydrogen-like atoms: time independent Schrodinger equation inspherical 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. Spacequantization. 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)

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 JJ couplings. Hund's Rule. Term symbols. Spectra of Hydrogen and AlkaliAtoms (Na etc.). (10 Lectures)

Reference Books:

- A Text book of Quantum Mechanics, P.M.Mathews and K.Venkatesan, 2nd Ed., 2010, McGraw Hill
- Quantum Mechanics, Robert Eisberg and Robert Resnick, 2nd Edn., 2002, Wiley.
- Quantum Mechanics, Leonard I. Schiff, 3rd Edn. 2010, Tata McGraw Hill.
- Quantum Mechanics, G. Aruldhas, 2nd Edn. 2002, PHI Learning of India.
- Quantum Mechanics, Bruce Cameron Reed, 2008, Jones and Bartlett Learning.
- Quantum Mechanics: Foundations & Applications, Arno Bohm, 3rd Edn., 1993, Springer
- Quantum Mechanics for Scientists & Engineers, D.A.B. Miller, 2008, Cambridge University Press

Additional Books for Reference

- Quantum Mechanics, Eugen Merzbacher, 2004, John Wiley and Sons, Inc.
- Introduction to Quantum Mechanics, D.J. Griffith, 2nd Ed. 2005, Pearson Education
- Quantum Mechanics, Walter Greiner, 4th Edn., 2001, Springer

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BSPH351A	QUANTUM MECHANICS AND APPLICATIONS LAB	L	T	P	C
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Course Objectives:

1. Acquire knowledge of time independent perturbed systems using Schrödinger's equation.
2. Know about the mechanism related to electronic transitions using time independent perturbed systems.
3. Get experimental significance of phenomenon of scattering quantum mechanically.
4. Deep insight about the co-relationship between relativity and quantum mechanics.

Course Outcomes:

1. Understanding of C/C++/ language
2. Experimental Formulation of time-dependent perturbed systems and their correlation between experimental phenomenon.
3. Comprehend the concepts of quantum mechanical treatment of scattering and applications.
4. Gain deeper understanding of relativistic quantum mechanical systems and their reduction in nonrelativistic form.

Course Content

Use C/C++/Scilab for solving the following problems based on Quantum Mechanics like

1. Solve the s-wave Schrodinger equation for the ground state and the first excited state of the hydrogen atom. Obtain the energy eigenvalues and plot the corresponding wavefunctions. Remember that the ground state energy of the hydrogen atom is ≈ -13.6 eV. Take e = 3.795 (eVÅ)1/2, ħc = 1973 (eVÅ) and m = 0.511x106 eV/c2.
2. Solve the s-wave radial Schrodinger equation for an atom. Find the energy (in eV) of the ground state of the atom to an accuracy of three significant digits. Also, plot the corresponding wavefunction. Take e = 3.795 (eVÅ)1/2, m = 0.511x106 eV/c2, and a = 3 Å, 5 Å, 7 Å. In these units ħc = 1973 (eVÅ). The ground state energy is expected to be above -12 eV in all three cases.
3. Solve the s-wave radial Schrodinger equation for a particle of mass m. Also, plot the corresponding wave function. Choose m = 940 MeV/c2, k = 100MeV fm-2, b = 0, 10, 30 MeV fm-3 In these units, cħ = 197.3 MeV fm. The ground state energy I expected to lie between 90 and 110 MeV for all three cases.
4. Solve the s-wave radial Schrodinger equation for the vibrations of hydrogen molecule. Find the lowest vibrational energy (in MeV) of the molecule to an accuracy of three significant digits. Also plot the corresponding wave function.

Take: m = 940x106 eV/C2, D = 0.755501 eV, α = 1.44, ro = 0.131349 Å

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Laboratory based experiments:

5. Study of Electron spin resonance- determine magnetic field as a function of the resonance frequency
6. Study of Zeeman effect: with external magnetic field; Hyperfine splitting
7. To show the tunneling effect in tunnel diode using I-V characteristics.
8. Quantum efficiency of CCDs

Reference Books:

- Schaum's outline of Programming with C++. J.Hubbard, 2000,McGraw-Hill Publication
- Numerical Recipes in C: The Art of Scientific Computing, W.H. Pressetal., 3rd Edn., 2007, Cambridge University Press.
- An introduction to computational Physics, T.Pang, 2nd Edn.,2006, Cambridge Univ. Press
- Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific & Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernández.2014 Springer.
- Scilab (A Free Software to Matlab): H. Ramchandran, A.S. Nair. 2011 S. Chand & Co.
- A Guide to MATLAB, B.R. Hunt, R.L. Lipsman, J.M. Rosenberg, 2014, 3rd Edn., Cambridge University Press
- Scilab Image Processing: L.M.Surhone.2010 Betascript Publishing ISBN:978-6133459274

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BSPH303A	SOLID STATE PHYSICS	L	T	P	C
		4	0	0	4

Course Objectives:

1. To acquire knowledge of crystal structure
2. Understanding the magnetic properties of matter
3. Better understanding of dielectric properties of Materials
4. Better understanding of semiconductors

Course Learning Outcomes:

1. Understand different types of crystals, miller indices and crystal defects.
2. Get knowledge about different types of magnetic materials and their practical applications.
3. Enhance deep insight of ferroelectricity and properties of ferroelectric materials
4. Get Better understanding of types of semiconductors and fermi energy.

Course Content

Crystal Structure: Solids: Amorphous and Crystalline Materials. Lattice TranslationVectors. 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. (12 Lectures)

Elementary Lattice Dynamics: Lattice Vibrations and Phonons: Linear Monoatomicand Diatomic Chains. Acoustical and Optical Phonons. Qualitative description of the Phonon Spectrum in Solids. Dulong and Petit's Law, Einstein and Debye theories ofspecific heat of solids. T3 law (10 Lectures)

Magnetic Properties of Matter: Dia-, Para-, Ferri- and Ferromagnetic Materials.Classical Langevin Theory of dia– and Paramagnetic Domains. Quantum Mechanical Treatment of Paramagnetism. Curie's law, Weiss's Theory of Ferromagnetism and Ferromagnetic Domains. Discussion of B-H Curve. Hysteresis and Energy Loss. (8 Lectures)

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. Cauchy and Sellmeir relations. Langevin-Debye equation. Complex Dielectric Constant. Optical Phenomena. Application: Plasma Oscillations, Plasma Frequency, Plasmons, TO modes. (8 Lectures)

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. (6 lectures)
Elementary band theory: Kronig Penny model. Band Gap. Conductor, Semiconductor (P and N type) and insulator. Conductivity of Semiconductor, mobility, Hall Effect. Measurement of conductivity (04 probe method) & Hall coefficient. (10 Lectures)

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) (6 Lectures)

Reference Books:

- Introduction to Solid State Physics, Charles Kittel, 8th Edition, 2004, Wiley India Pvt. Ltd.
- Elements of Solid State Physics, J.P. Srivastava, 4th Edition, 2015, Prentice-Hall of India
- Introduction to Solids, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill
- Solid State Physics, N.W. Ashcroft and N.D. Mermin, 1976, Cengage Learning
- Solid-state Physics, H. Ibach and H. Luth, 2009, Springer
- Solid State Physics, Rita John, 2014, McGraw Hill
- Elementary Solid State Physics, 1/e M. Ali Omar, 1999, Pearson India
- Solid State Physics, M.A. Wahab, 2011, Narosa Publications

BSPH353A	SOLID STATE PHYSICS LAB	L	T	P	C
		0	0	4	2

Course Objectives:

1. Learn the basics of dielectric properties of the materials.
2. Develop an understanding of about Ferroelectric properties
3. Understanding the source of magnetic behaviour of the materials and experimental verification.
4. Experiments related to magnetism.

Course Learning Outcomes:

1. Better understanding of dielectric properties of the materials.
2. Understanding of semiconductor properties.
3. Deep insight about the magnetic behaviour and its source through experiments.
4. Enhanced experimental knowledge about Ferroelectric properties

Course Content

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.

Reference Books:

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

BSPH305A	**BASIC INSTRUMENTATION SKILLS**	**L**	**T**	**P**	**C**
		2	**2**	**0**	**4**

Course Objectives:

1. Dedicated demonstration cum hands on sessions on the construction, functioning and uses of different measuring Instruments such as Voltmeter, Ammeter, Multimeter, CRO, Function Generator etc.
2. To learn difference between analog and digital meters.
3. Sessions on the review of scientific laboratory report writing, and on experimental data analysis.
4. Expand and exercise the students' physical intuition and thinking process through the experiments.
5. Interpretation of experimental data

Course Learning Outcomes:

1. Acquire fundamental knowledge of laboratory instruments and their uses.
2. Better insight about difference in working of digital and analog instruments.
3. Understand basics of measurement and error analysis.
4. Learn techniques related to data analysis and curve fitting.

Course Content

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 voltagemeasurement 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)

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)

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)

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.

Open Ended Experiments:
1. Using a Dual Trace Oscilloscope
2. Converting the range of a given measuring instrument (voltmeter, ammeter)

Reference Books:

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

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BSPH307A	CLASSICAL DYNAMICS	L	T	P	C
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Course Objectives:

1. To familiarize the student with the e drawbacks of Newtonian approach and necessity of new approaches to solve problems involving the classical mechanical systems.

2. To understand the mechanics of small amplitude oscillations and normal modes of oscillations.

3. To acquire knowledge of special theory of relativity and understand two-body decay of an unstable particle.

4. To understand the concepts of fluid dynamics in terms of classical mechanics.

Course Learning Outcomes:

1. Define and understand basic mechanical concepts involving the dynamic motion of classical mechanical systems.
2. To solve the problems related to potential energy, oscillations and normal mode of oscillations of classical mechanical systems.
3. Solve problems of special theory of relativity s using the Lagrangian and Hamiltonian formulations of classical mechanics
4. Gain deeper understanding of classical treatment of problems in fluid dynamics.

Course Content

Classical Mechanics of Point Particles: Review of Newtonian Mechanics; Applicationto the motion of a charge particle in external electric and magnetic fields- motion in uniform electric field, magnetic field- gyroradius and gyrofrequency, motion in crossed electric and magnetic fields. Generalized coordinates and velocities, Hamilton's principle, Lagrangian and the Euler-Lagrange equations, one-dimensional examples of the Euler-Lagrange equations- one dimensional Simple Harmonic Oscillations and falling body in uniform gravity; applications to simple systems such as coupled oscillators Canonical momenta & Hamiltonian. Hamilton's equations of motion.

Applications: Hamiltonian for a harmonic oscillator, solution of Hamilton's equation for Simple Harmonic Oscillations; particle in a central force field- conservation of angular momentum and energy. (22 Lectures)

Small Amplitude Oscillations: Minima of potential energy and points of stable equilibrium, expansion of the potential energy around a minimum, small amplitude oscillations about the minimum, normal modes of oscillations example of N identical masses connected in a linear fashion to (N -1) - identical springs. (10 Lectures)

Special Theory of Relativity: Postulates of Special Theory of Relativity. Lorentz Transformations. Minkowski space. The invariant interval, light cone and world lines. Spacetime diagrams. Time -dilation, length contraction and twin paradox. Four-vectors: space-like, time-like and light-like. Four-velocity and acceleration. Metric and alternating tensors. Fourmomentum and energy-momentum relation. Doppler effect from a four-vector perspective. Concept of four-force. Conservation of four-momentum. Relativistic kinematics. Application to two-body decay of an unstable particle. (33 Lectures)

Fluid Dynamics: Density and pressure P in a fluid, an element of fluid and its velocity, continuity equation and mass conservation, stream-lined motion, laminar flow, Poiseuille's equation for flow of a liquid through a pipe, Navier-Stokes equation, qualitative description of turbulence, Reynolds number. (10 Lectures)

Reference Books:

- Classical Mechanics, H.Goldstein, C.P. Poole, J.L. Safko, 3rd Edn. 2002,Pearson Education.
- Mechanics, L. D. Landau and E. M. Lifshitz, 1976, Pergamon.
- Classical Electrodynamics, J.D. Jackson, 3rd Edn., 1998, Wiley.
- The Classical Theory of Fields, L.D Landau, E.M Lifshitz, 4th Edn., 2003, Elsevier.
- Introduction to Electrodynamics, D.J. Griffiths, 2012, Pearson Education.
- Classical Mechanics, P.S. Joag, N.C. Rana, 1st Edn., McGraw Hall.
- Classical Mechanics, R. Douglas Gregory, 2015, Cambridge University Press.
- Classical Mechanics: An introduction, Dieter Strauch, 2009, Springer.
- Solved Problems in classical Mechanics, O.L. Delange and J. Pierrus, 2010, Oxford Press

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BSPH309A	NUCLEAR AND PARTICLE PHYSICS	L	T	P	C
		5	1	0	6

Course Objectives:

1. To familiarize the student with the constituents of nucleus, their intrinsic properties and nuclear models.

2. To understand the processes involved in radioactive decay and types of nuclear reactions.

3. To acquire knowledge of interaction of nuclear radiation with matter, detectors and accelerators for nuclear radiations.

4. To have an insight about various types of elementary particles and their interactions.

Course Learning Outcomes:

1. Better understand the basics of nucleus, nucleons, their properties and models.
2. Comprehend the concept of radioactive disintegration and nuclear reactions.
3. Have an understanding of characteristics of nuclear radiations and working of nuclear detectors and accelerators
4. Gain deeper understanding of particle interactions and the laws governing the interactions.

Course Content

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)

Nuclear Models: Liquid drop model approach, semi empirical mass formula andsignificance 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. (12 Lectures)
Radioactivity decay: (a) Alpha decay: basics of α-decay processes, theory of α-emission, Gamow factor, Geiger Nuttall law, α-decay spectroscopy. (b) □-decay: energy kinematics for □- decay, positron emission, electron capture, neutrino hypothesis. (c) Gamma decay: Gamma rays emission & kinematics, internal conversion. (10 Lectures)

Nuclear Reactions: Types of Reactions, Conservation Laws, kinematics of reactions, Q-value, reaction rate, reaction cross section, Concept of compound and direct Reaction, resonance reaction, Coulomb scattering (Rutherford scattering). (8 Lectures)
Interaction of Nuclear Radiation with matter: Energy loss due to ionization (Bethe-Block formula), energy loss of electrons, Cerenkov radiation. Gamma ray interaction through matter, photoelectric effect, Compton scattering, pair production, neutron interaction with matter. (8 Lectures)

Detector for Nuclear Radiations: Gas detectors: estimation of electric field, mobility of particle, for ionization chamber and GM Counter. Basic principle of Scintillation Detectors and construction of photo-multiplier tube (PMT). Semiconductor Detectors (Si and Ge) for charge particle and photon detection (concept of charge carrier and mobility), neutron detector. (8 Lectures)

Particle Accelerators: Accelerator facility available in India: Van-de Graaff Generator (Tandem accelerator), Linear accelerator, Cyclotron, Synchrotrons. (5 Lectures)

Particle physics: Particle interactions; basic features, types of particles and its families. Symmetries and Conservation Laws: energy and momentum, angular momentum, parity, baryon number, Lepton number, Isospin, Strangeness and charm, concept of quarkmodel, color quantum number and gluons. (14 Lectures)

Reference Books:

- Introductory nuclear Physics by Kenneth S. Krane (Wiley India Pvt. Ltd., 2008).
- Concepts of nuclear physics by Bernard L. Cohen. (Tata Mcgraw Hill, 1998).
- Introduction to the physics of nuclei & particles, R.A. Dunlap. (Thomson Asia, 2004).
- Introduction to High Energy Physics, D.H. Perkins, Cambridge Univ. Press
- Introduction to Elementary Particles, D. Griffith, John Wiley & Sons
- Quarks and Leptons, F. Halzen and A.D. Martin, Wiley India, New Delhi
- Basic ideas and concepts in Nuclear Physics - An Introductory Approach by K. Heyde (IOP Institute of Physics Publishing, 2004).
- Radiation detection and measurement, G.F. Knoll (John Wiley & Sons, 2000).
- Physics and Engineering of Radiation Detection, Syed Naeem Ahmed (Academic Press, Elsevier, 2007).
- Theoretical Nuclear Physics, J.M. Blatt & V.F.Weisskopf (Dover Pub.Inc., 1991)

SEMESTER-VI

		L	T	P	C
BSPH302A	**ELECTROMAGNETIC THEORY**	**4**	**0**	**0**	**4**

Course Objectives:

1. To familiarize the student with the fundamentals of electromagnetic waves, Maxwell's equations and electromagnetic energy density associated with electromagnetic waves.
2. To understand the factors governing the propagation of EM waves in unbounded and bounded media.
3. To acquire knowledge of polarization of electromagnetic waves.
4. To have an insight about wave guides and optical fibres.

Course Learning Outcomes:

1. Better understand the basics of electromagnetic waves and wave equations.
2. Comprehend the concept of propagation of EM waves in different media under different conditions.
3. Have an understanding of different types of polarization of EM waves.
4. Gain deeper understanding of propagation of EM waves through waveguides and optical fibres.

Course Content

Maxwell Equations: Review of Maxwell's equations. Displacement Current. Vectorand 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 andisotropic 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)

EM Wave in Bounded Media: Boundary conditions at a plane interface between twomedia. 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)

Polarization of Electromagnetic Waves: Description of Linear, Circular and EllipticalPolarization. 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)

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

Wave Guides: Planar optical wave guides. Planar dielectric wave guide. Condition ofcontinuity 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 and Graded Indices (Definitions Only). Single and Multiple Mode Fibres (Concept and Definition Only). (3 Lectures)

Reference Books:

- Introduction to Electrodynamics, D.J. Griffiths, 3rd Ed., 1998, Benjamin Cummings.
- Elements of Electromagnetics, M.N.O. Sadiku, 2001, Oxford University Press.
- Introduction to Electromagnetic Theory, T.L. Chow, 2006, Jones & Bartlett Learning
- Fundamentals of Electromagnetics, M.A.W. Miah, 1982, Tata McGraw Hill
- Electromagnetic field Theory, R.S. Kshetrimayun, 2012, Cengage Learning
- Engineering Electromagnetic, Willian H. Hayt, 8th Edition, 2012, McGraw Hill.
- Electromagnetic Field Theory for Engineers & Physicists, G. Lehner, 2010, Springer

Additional Books for Reference

- Electromagnetic Fields & Waves, P.Lorrain & D.Corson, 1970, W.H.Freeman & Co.
- Electromagnetics, J.A. Edminster, Schaum Series, 2006, Tata McGraw Hill.
- Electromagnetic field theory fundamentals, B. Guru and H. Hiziroglu, 2004,Cambridge University Press

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BSPH352A	ELECTROMAGNETIC THEORY LAB	L	T	P	C
		0	0	4	2

Course Objectives:

1. Demonstration cum laboratory sessions on the concepts of electromagnetic theory such as polarization, reflection, refraction of EM waves.
2. Sessions on the review of scientific laboratory report writing, and on experimental data analysis.
3. Expand and exercise the students' physical intuition and thinking process through the experiments.
4. Interpretation of experimental data.

Course Learning Outcomes:

1. Acquire fundamental knowledge of laboratory instruments and their uses.
2. Better insight about data collection techniques.
3. Better understanding of data interpretation and error analysis.
4. Acquire knowledge about the techniques related data analysis and curve fitting

Course Content

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 airfilm.
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 airglass 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:

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

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		L	T	P	C
BSPH304A	**STATISTICAL MECHANICS**	**4**	**0**	**0**	**4**

Course Objectives:

1. To make them learn about the classical statistics and its applications.
2. To enable them to use classical theory of radiation to solve some problems of physics.
3. To give knowledge of quantum theory of radiation.
4. To impart knowledge about Bose Einstein statistics and Fermi Dirac statistics.

Course Learning Outcomes:

1. Apply concepts of classical statistics in solving problems of interest to physicists.
2. Better understand classical theory of radiation.
3. Understand use of quantum theory of radiation.
4. Solve equations encountered in Physics and Engineering using Bose Einstein statistics and Fermi Dirac statistics.

Course Content

Classical Statistics: Macrostate & Microstate, Elementary Concept of Ensemble, PhaseSpace, 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. (18 Lectures)

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)

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)

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:

- Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University Press.

- Statistical Physics, Berkeley Physics Course, F. Reif, 2008, Tata McGraw-Hill
- Statistical and Thermal Physics, S. Lokanathan and R.S. Gambhir. 1991, Prentice Hall
- Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W. Sears and Gerhard L. Salinger, 1986, Narosa.
- Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer
- An Introduction to Statistical Mechanics & Thermodynamics, R.H. Swendsen, 2012, Oxford Univ. Press

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BSPH354A	STATISTICAL MECHANICS LAB	L	T	P	C
		0	0	4	2

Course Objectives:

1. To make them learn about the classical statistics and its applications.
2. To enable them to use classical theory of radiation to solve some problems of physics.
3. To give knowledge of quantum theory of radiation.
4. To impart knowledge about Bose Einstein statistics and Fermi Dirac statistics.

Course Learning Outcomes:

1. Apply concepts of classical statistics in solving problems of interest to physicists.
2. Better understand classical theory of radiation.
3. Understand use of quantum theory of radiation.
4. Solve equations encountered in Physics and Engineering using Bose Einstein statistics and Fermi Dirac statistics.

Course Content

Use C/C++/Scilab/other numerical simulations for solving the problems based on Statistical Mechanics like

1. Computational analysis of the behavior of a collection of particles in a box that satisfy Newtonian mechanics and interact via the Lennard-Jones potential, varying the total number of particles N and the initial conditions:

a) Study of local number density in the equilibrium state (i) average; (ii) fluctuations

b) Study of transient behavior of the system (approach to equilibrium)

c) Relationship of large N and the arrow of time

d) Computation of the velocity distribution of particles for the system and comparison with the Maxwell velocity distribution

e) Computation and study of mean molecular speed and its dependence on particle mass

f) Computation of fraction of molecules in an ideal gas having speed near the most probable speed

2. Computation of the partition function $Z(\beta)$ for examples of systems with a finite number of single particle levels (e.g., 2 level, 3 level, etc.) and a finite number of non-interacting particles N under Maxwell-Boltzmann, Fermi-Dirac and Bose-Einstein statistics:

a) Study of how $Z(\beta)$, average energy $\langle E \rangle$, energy fluctuation ΔE, specific heat at constant volume C_v, depend upon the temperature, total number of particles N and the spectrum of single particle states.

b) Ratios of occupation numbers of various states for the systems considered above

c) Computation of physical quantities at large and small temperature T and comparison of various statistics at large and small temperature T.

3. Plot Planck's law for Black Body radiation and compare it with Raleigh-Jeans Law at high temperature and low temperature.

4. Plot Specific Heat of Solids (a) Dulong-Petit law, (b) Einstein distribution function, (c) Debye

distribution function for high temperature and low temperature and compare them for these two cases.

5. Plot the following functions with energy at different temperatures

a) Maxwell-Boltzmann distribution

b) Fermi-Dirac distribution

c) Bose-Einstein distribution

Reference Books:

- Elementary Numerical Analysis, K.E.Atkinson, 3 r d E d n . 2 0 0 7, Wiley India Edition
- Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University Press.
- Introduction to Modern Statistical Mechanics, D. Chandler, Oxford University Press, 1987
- Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W. Sears and
Gerhard L. Salinger, 1986, Narosa.
- Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer
- Statistical and Thermal Physics with computer applications, Harvey Gould and Jan
- Tobochnik, Princeton University Press, 2010.
- Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientificand
- Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernández. 2014Springer
- ISBN: 978-3319067896Scilab by example: M. Affouf, 2012. ISBN: 978-1479203444
- Scilab Image Processing: L.M.Surhone. 2010, Betascript Pub., ISBN: 978-6133459274

BSPH306A	APPLIED OPTICS	L	T	P	C
		2	2	0	4

Course Objectives:

1. To prepare the students to have basic ideas in.Applied Optics.
2. To introduce advance level experiments in the area of Fourier Optics, Fibre Optics, Lasers and holography.
3. To understand the working mechanism of various Laser systems and detectors.
4. To acquire knowledge of application areas of Fourier Optics and Fibre Optics.

Course Learning Outcomes:

1. Get familiar with the laboratory experimental set ups related to Applied Optics.
2. Acquire the knowledge of fundamentals of Fourier Optics, Fibre Optics and Holography.
3. Understand the working of Lasers and other detectors such as LDR, LED, photodiode and IR sensor.
4. Recognize the applications of Fourier Optics, Fibre Optics and Holography in real world.

Course Content

Theory includes only qualitative explanation. Minimum five experiments should be performed covering minimum three sections.

(i) Sources and Detectors (9 Lectures)

Lasers, Spontaneous and stimulated emissions, Theory of laser action, Einstein's coefficients, Light amplification, Characterization of laser beam, He-Ne laser, Semiconductor lasers.

Experiments on Lasers:

a. Determination of the grating radial spacing of the Compact Disc (CD) by reflection using He-Ne or solid state laser.
b. To find the width of the wire or width of the slit using diffraction pattern obtained by a He-Ne or solid state laser.
c. To find the polarization angle of laser light using polarizer and analyzer
d. Thermal expansion of quartz using laser

Experiments on Semiconductor Sources and Detectors:

a. V-I characteristics of LED
b. Study the characteristics of solid state laser
c. Study the characteristics of LDR
d. Photovoltaic Cell
e. Characteristics of IR sensor

(ii) Fourier Optics (6 Lectures)

Concept of Spatial frequency filtering, Fourier transforming property of a thin lens

Experiments on Fourier Optics:

a. Fourier optic and image processing
1. Optical image addition/subtraction
2. Optical image differentiation
3. Fourier optical filtering
4. Construction of an optical 4f system
b. Fourier Transform Spectroscopy

Fourier Transform Spectroscopy (FTS) is a powerful method for measuring emission and absorption spectra, with wide application in atmospheric remote sensing, NMR spectrometry and forensic science.

Experiment:

To study the interference pattern from a Michelson interferometer as a function of mirror separation in the interferometer. The resulting interferogram is the Fourier transform of the power spectrum of the source. Analysis of experimental interferograms allows one to determine the transmission characteristics of several interference filters. Computer simulation can also be done.

(iii) Holography (6 Lectures)
Basic principle and theory: coherence, resolution, Types of holograms, white light reflection hologram, application of holography in microscopy, interferometry, and character recognition

Experiments on Holography and interferometry:
1. Recording and reconstructing holograms
2. Constructing a Michelson interferometer or a Fabry Perot interferometer
3. Measuring the refractive index of air
4. Constructing a Sagnac interferometer
5. Constructing a Mach-Zehnder interferometer
6. White light Hologram

(iv) Photonics: Fibre Optics (9 Lectures)
Optical fibres and their properties, Principal of light propagation through a fibre, The numerical aperture, Attenuation in optical fibre and attenuation limit, Single mode and multimode fibres, Fibre optic sensors: Fibre Bragg Grating

Experiments on Photonics: Fibre Optics
a. To measure the numerical aperture of an optical fibre
b. To study the variation of the bending loss in a multimode fibre
c. To determine the mode field diameter (MFD) of fundamental mode in a single-mode fibre by measurements of its far field Gaussian pattern To measure the near field intensity profile of a fibre and study its refractive index profile and To determine the power loss at a splice between two multimode fibre

Reference Books:

- Fundamental of optics, F. A. Jenkins & H. E. White, 1981, Tata McGraw hill.
- LASERS: Fundamentals & applications, K.Thyagrajan & A.K.Ghatak, 2010, Tata McGraw Hill
- Fibre optics through experiments, M.R.Shenoy, S.K.Khijwania, et.al. 2009, Viva Books
- Nonlinear Optics, Robert W. Boyd, (Chapter-I), 2008, Elsevier.
- Optics, Karl Dieter Moller, Learning by computing with model examples, 2007, Springer.
- Optical Systems and Processes, Joseph Shamir, 2009, PHI Learning Pvt. Ltd.
- Optoelectronic Devices and Systems, S.C. Gupta, 2005, PHI Learning Pvt. Ltd.
- Optical Physics, A.Lipson, S.G.Lipson, H.Lipson, 4th Edn., 1996, Cambridge Univ. Press

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BSPH308A	PHYSICS OF EARTH	L	T	P	C
		5	1	0	6

Course Objectives:

1. To acquire the holistic understanding of planet earth.
2. To understand the structure and formation of earth and its atmosphere.
3. To comprehend the dynamical processes governing earth.
4. To gain the insight of evolution and origin of life on earth as well as the factors disturbing the survival on planet.

Course Learning Outcomes:

1. The students will be able learn about universe-galaxies, solar system and cosmic background.
2. Enable students to know the structure of earth and the four components- hydrosphere, atmosphere, cryosphere and biosphere.
3. Understanding the dynamical processes taking place on earth and also the detailed view of weather and climatic changes.
4. Understand origin of life on earth, Introduction to the geology and geomorphology of Indian subcontinent as well as the disturbing elements for the planet.

Course Content

The Earth and the Universe: (17 Lectures)

(a) Origin of universe, creation of elements and earth. A Holistic understanding of our dynamic planet through Astronomy, Geology, Meteorology and Oceanography. Introduction to various branches of Earth Sciences.

(b) General characteristics and origin of the Universe. The Milky Way galaxy, solar system, Earth's orbit and spin, the Moon's orbit and spin. The terrestrial and Jovian planets. Meteorites & Asteroids. Earth in the Solar system, origin, size, shape, mass, density, rotational and revolution parameters and its age.

(c) Energy and particle fluxes incident on the Earth.

(d) The Cosmic Microwave Background.

Structure: (18 Lectures)

(a) The Solid Earth: Mass, dimensions, shape and topography, internal structure, magnetic field, geothermal energy. How do we learn about Earth's interior?

(b) The Hydrosphere: The oceans, their extent, depth, volume, chemical composition. River systems.

(c) The Atmosphere: variation of temperature, density and composition with altitude, clouds.

(d) The Cryosphere: Polar caps and ice sheets. Mountain glaciers.

(e) The Biosphere: Plants and animals. Chemical composition, mass. Marine and land organisms.

Dynamical Processes: (18 Lectures)

(a) The Solid Earth: Origin of the magnetic field. Source of geothermal energy. Convection in Earth's core and production of its magnetic field. Mechanical layering of the Earth.
Introduction to geophysical methods of earth investigations. Concept of plate tectonics; seafloor
spreading and continental drift. Geodynamic elements of Earth: Mid Oceanic Ridges, trenches, transform faults and island arcs. Origin of oceans, continents, mountains and rift valleys. Earthquake and earthquake belts. Volcanoes: types products and distribution.
(b) The Hydrosphere: Ocean circulations. Oceanic current system and effect of coriolis forces. Concepts of eustasy, tend – air-sea interaction; wave erosion and beach processes. Tides. Tsunamis.
(c) The Atmosphere: Atmospheric circulation. Weather and climatic changes. Earth's heat budget. Cyclones.
Climate:
i. Earth's temperature and greenhouse effect.
ii. Paleoclimate and recent climate changes.
iii. The Indian monsoon system.
(d) Biosphere: Water cycle, Carbon cycle, Nitrogen cycle, Phosphorous cycle. The role of cycles in maintaining a steady state.

Evolution: (18 Lectures)

Nature of stratigraphic records, Standard stratigraphic time scale and introduction to the concept
of time in geological studies. Introduction to geochronological methods in their application in geological studies. History of development in concepts of uniformitarianism, catastrophism and
neptunism. Law of superposition and faunal succession. Introduction to the geology and geomorphology of Indian subcontinent.
1. Time line of major geological and biological events.
2. Origin of life on Earth.
3. Role of the biosphere in shaping the environment.
4. Future of evolution of the Earth and solar system: Death of the Earth.

Disturbing the Earth – Contemporary dilemmas (4 Lectures)

(a) Human population growth.
(b) Atmosphere: Green house gas emissions, climate change, air pollution.
(c) Hydrosphere: Fresh water depletion.
(d) Geosphere: Chemical effluents, nuclear waste.
(e) Biosphere: Biodiversity loss. Deforestation. Robustness and fragility of ecosystems.

Reference Books:

- Planetary Surface Processes, H. Jay Melosh, Cambridge University Press, 2011.
- Consider a Spherical Cow: A course in environmental problem solving, John Harte. University Science Books
- Holme's Principles of Physical Geology. 1992. Chapman & Hall.
- Emiliani, C, 1992. Planet Earth, Cosmology, Geology and the Evolution of Life and Environment. Cambridge University Press.

BSPH356A	DISSERTATION	L	T	P	C
		0	0	0	6

Course Objectives:

1. To learn how to carry out literature survey
2. To be associated with an area of research/research project and contribute towards domain knowledge.
3. To learn the art of technical report writing
4. To learn the art of verbal communication with the help of modern presentation techniques.

Course Learning Outcomes:

1. Know the concept, scope of research.
2. Enable the students to gain knowledge on particular areas of research.
3. Understand the scientific methods to study region.
4. Analyze the practical knowledge of research and apply the subject matter knowledge in the field.
5. Learn the art of reporting.
6. Able to educate the technical skill of writing.
7. Demonstrate an ability to present and defend their research work to a panel of experts.

BSMA215A	PROBABILTY AND STATISTICS	L	T	P	C
		4	0	0	4

Course Objectives:

1. To understand fundamental concepts of probability theory, including conditional probability, independence, and Bayes' theorem, and apply them to solve problems involving random variables.

2. To analyze and apply univariate discrete and continuous probability distributions, including their properties, probability mass/density functions, and moment generating

functions, to model and interpret real-world phenomena.

3. To explore bivariate probability distributions, including joint cumulative distribution functions, marginal distributions, and conditional distributions, and apply them to analyze relationships between two random variables.
4. To understand and apply correlation, regression, and the central limit theorem, including calculating correlation coefficients, performing linear regression, and interpreting the central limit theorem, in modeling and analyzing uncertainty in various contexts.

Course Learning Outcomes:

1. Students will demonstrate proficiency in applying fundamental probability concepts such as conditional probability and independence to analyze and solve problems involving uncertainty and random variables.
2. Students will gain the ability to analyze and apply various univariate discrete and continuous probability distributions, including their probability functions and moment generating functions, to model and analyze real-world phenomena accurately.
3. Students will develop skills in analyzing bivariate probability distributions, including joint distributions and conditional distributions, enabling them to understand and interpret relationships between two random variables effectively.
4. Students will demonstrate competency in applying correlation, regression, and the central limit theorem to analyze uncertainty and make predictions, enabling them to model and analyze uncertainty in various contexts effectively.

Catalog Description

This course aims to provide an understanding of the basic concepts in probability, conditional probability and independent events. It will also focus on the random variable, mathematical expectation, and different types of univariate and bivariate distributions. In this course, student will learn how to describe relationships between two numerical quantities and characterized these relationships graphically, in the form of summary statistics, and through simple linear regression models.

Course Content

UNIT-I **15 Lectures**
Probability Functions and Moment Generating Function

Basic notions of probability, Conditional probability and independence, Baye's theorem; Random variables - Discrete and continuous, Cumulative distribution function, Probability mass/density functions; Transformations, Mathematical expectation, Moments, Moment generating function, Characteristic function.

UNIT-II **15 Lectures**

Univariate Discrete and Continuous Distributions

Discrete distributions**:** Uniform, Bernoulli, Binomial, Negative binomial, Geometric and Poisson; Continuous distributions**:** Uniform, Gamma, Exponential, Chi-square, Beta and normal; Normal approximation to the binomial distribution.

UNIT-III **16 Lectures**

Bivariate Distribution

Joint cumulative distribution function and its properties, Joint probability density function, Marginal distributions, Expectation of function of two random variables, Joint moment generating function, Conditional distributions and expectations.

UNIT-IV **14 Lectures**

Correlation, Regression and Central Limit Theorem

The Correlation coefficient, Covariance, Calculation of covariance from joint moment generating function, Independent random variables, Linear regression for two variables, The method of least squares, Bivariate normal distribution, Chebyshev's theorem, Strong law of large numbers, Central limit theorem and weak law of large numbers.

Modeling Uncertainty

Uncertainty, Information and entropy, Uniform Priors, Polya's urn model and random graphs.

Reference Books/Materials

1. Robert V. Hogg, Joseph W. McKean & Allen T. Craig (2013). *Introduction to Mathematical Statistics* (7th edition), Pearson Education.

2. Irwin Miller &Marylees Miller (2014). *John E. Freund's Mathematical Statistics with Applications* (8thedition). Pearson. Dorling Kindersley Pvt. Ltd. India.

3. Jim Pitman (1993). *Probability*, Springer-Verlag.
4. Sheldon M. Ross (2014). *Introduction to Probability Models* (11th edition). Elsevier.
5. A. M. Yaglom and I. M. Yaglom (1983). *Probability and Information*. D. Reidel Publishing Company. Distributed by Hindustan Publishing Corporation (India) Delhi.

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<tr><td rowspan="2">BSMA271A</td><td rowspan="2">PROBABILTY AND STATISTICS LAB</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>0</td><td>0</td><td>4</td><td>2</td></tr>
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Course Objectives:

1. To understand the principles of graphical representation of data, including various types of graphs and charts, and their applications in visualizing and interpreting data.
2. To apply measures of central tendency such as mean, median, and mode to analyze data sets and solve problems related to central tendency.
3. To analyze measures of dispersion such as range, variance, and standard deviation, and

apply them to interpret data variability and solve related problems.

4. To solve problems involving combined measures of central tendency and dispersion, including mean, variance, and coefficient of variation, to analyze and compare data sets effectively.

Course Learning Outcomes:

1. Students will be able to create and interpret various graphical representations of data, including histograms, frequency polygons, and pie charts, enhancing their ability to communicate and analyze data visually.
2. Students will demonstrate proficiency in applying measures of central tendency such as mean, median, and mode to describe and summarize data sets accurately, enabling them to interpret and compare data effectively.
3. Students will develop skills in analyzing measures of dispersion such as range, variance, and standard deviation, enabling them to assess the spread and variability of data sets and make informed decisions.
4. Students will gain the ability to analyze and compare data sets using combined measures of central tendency and dispersion, including mean, variance, and coefficient of variation, enhancing their ability to evaluate and interpret data in various contexts.

Catalog Description

We generally do not pay attention to the significance of statistics but its significance can be seen from business to politics or from agriculture to sports. This course shall begin with elementary statistical concepts such measures of central tendency and measures of dispersion. Furthermore, some more advanced concepts like correlation and regression are planned to be uncovered. Also students shall learn to determine the probability of an event, and to apply both discrete and continuous probability distributions to practical human problems.

Course Content

List of Practical

1. Graphical representation of data.
2. Problems based on measures of central tendency.
3. Problems based on measures of dispersion.
4. Problems based on combined mean and variance and coefficient of variation.
5. Problems based on moments, skewness and kurtosis.
6. Fitting of polynomials, exponential curves.
7. Karl Pearson correlation coefficient.
8. Correlation coefficient for a bivariate frequency distribution.
9. Lines of regression, angle between lines and estimated values of variables.
10. Spearman rank correlation with and without ties.
11. Partial and multiple correlations.
12. Planes of regression and variances of residuals for given simple correlations.
13. Planes of regression and variances of residuals for raw data.

14. Fitting of binomial distributions for n and p = q = ½.
15. Fitting of binomial distributions for given n and p.
16. Fitting of binomial distributions after computing mean and variance.
17. Fitting of Poisson distributions for given value of lambda.
18. Fitting of Poisson distributions after computing mean.
19. Fitting of negative binomial.
20. Application problems based on binomial distribution.
21. Application problems based on Poisson distribution.
22. Application problems based on negative binomial distribution.
23. Problems based on area property of normal distribution.
24. To find the ordinate for a given area for normal distribution.
25. Application based problems using normal distribution.
26. Fitting of normal distribution when parameters are given.
27. Fitting of normal distribution when parameters are not given.
28. Fitting of Binomial, Poisson distribution and apply Chi-square test for goodness of fit.

Reference Books/Materials

1. Robert V. Hogg, Joseph W. McKean & Allen T. Craig (2013). *Introduction to Mathematical Statistics* (7th edition), Pearson Education.
2. Irwin Miller & Marylees Miller (2014). *John E. Freund's Mathematical Statistics with Applications* (8thedition). Pearson. Dorling Kindersley Pvt. Ltd. India.
3. Jim Pitman (1993). *Probability*, Springer-Verlag.
4. Sheldon M. Ross (2014). *Introduction to Probability Models* (11th edition). Elsevier.
5. A. M. Yaglom and I. M. Yaglom (1983). *Probability and Information*. D. Reidel Publishing Company. Distributed by Hindustan Publishing Corporation (India) Delhi.

BSMA304A	**LINEAR PROGRAMMING**	**L**	**T**	**P**	**C**
		4	**0**	**0**	**4**

Course Objectives:

1. To understand the concepts of linear programming problem (LPP), convexity, and basic feasible solutions, including their formulation, canonical and standard forms, and graphical representation using the graphical method.

2. To explore the simplex method, a fundamental algorithm for solving LPPs, including optimality criteria, improving basic feasible solutions, and identifying unboundedness or optimal solutions.

3. To formulate and analyze the dual problem of linear programming, understanding duality theorems, complementary slackness theorem, and the economic interpretation

of the dual problem.

4. To study transportation problems and assignment problems, including their formulation, methods for finding initial basic feasible solutions, and algorithms for obtaining optimal solutions.

Course Learning Outcomes:

1. Students will be able to formulate and solve linear programming problems, understanding the concepts of convexity, basic feasible solutions, and their graphical representations, and apply appropriate methods to analyze and optimize linear systems.
2. Students will demonstrate proficiency in applying the simplex method to solve linear programming problems, identifying optimal solutions, unboundedness, and alternate optimal solutions, and interpreting results using tableau format.
3. Students will gain an understanding of duality in linear programming, including formulating and solving dual problems, interpreting economic implications, and applying the dual-simplex method effectively.
4. Students will develop skills in formulating and solving transportation and assignment problems, including identifying initial basic feasible solutions and applying algorithms such as the Northwest-corner rule, least-cost method, Vogel approximation method, and Hungarian method to obtain optimal solutions for real-world optimization challenges.

Catalog Description

This course covers some core areas of Operational Research, namely Linear programming, Transportation problem, Assignment problem and Game Theory. Emphasis will be placed both on the mathematical techniques and on problem formulation through examples from applications.

Course Content

UNIT – I **14 lecture hours**

Linear Programming Problem, Convexity and Basic Feasible Solutions,Formulation, Canonical and standard forms, Graphical method; Convex and polyhedral sets,Hyperplanes, Extreme points; Basic solutions, Basic Feasible Solutions, Reduction of feasible solution to basic feasible solution, Correspondence between basic feasible solutions and extreme points.

Unit II **14 lecture hours**

Simplex Method

Optimality criterion, improving a basic feasible solution, Unboundedness, Unique and alternate optimal solutions; Simplex algorithm and its tableau format; Artificial variables, Two-phase method, Big-M method.

Unit III **16 lecture hours**

Formulation of the dual problem, Duality theorems, Complimentary slackness theorem, Economic interpretation of the dual, Dual-simplex method.

Unit IV: **16 lecture hours**

Transportation Problem: Definition and formulation, Methods of finding initial basic feasible solutions: Northwest-corner rule, Least- cost method, Vogel approximation method; Algorithm for obtaining optimal solution. Assignment Problem: Mathematical formulation and Hungarian method.

Game Theory: Formulation and solution of two-person zero-sum games, Games with mixed strategies, Linear programming method for solving a game.

Textbooks

Kanti Swarup, P.K. Gupta and Manmohan, Operations Research, Sultan Chand & Sonsv

Reference Books/Materials

1. H.A. Taha, Operation Research-An introducton, Printice Hall of India.
2. P.K. Gupta and D.S. Hira, Operations Research, S. Chand & Co.
3. S.D. Sharma, Operation Research, Kedar Nath Ram Nath Publications

BSMA374A	**LINEAR PROGRAMMING LAB**	**L**	**T**	**P**	**C**
		0	**0**	**4**	**2**

Course Objectives:

1. To understand and apply the graphical method for solving linear programming problems (LPP), enabling students to visualize and interpret solutions geometrically.
2. To develop proficiency in solving LPPs using the simplex method, a fundamental algorithm for optimizing linear objective functions subject to linear constraints.
3. To explore the concept of duality in linear programming and learn how to find the dual of a given linear programming problem using the simplex method.
4. To investigate and understand the initial basic feasible solution of transportation problems, an essential step in solving transportation optimization challenges.
5. To analyze the optimality test criteria for transportation problems, enabling students to determine when a transportation solution is optimal and how to interpret the results.

6. To obtain solutions for balanced and unbalanced assignment problems, developing skills in assigning tasks or resources optimally in various scenarios.

Course Learning Outcomes:

1. Students will be able to apply the graphical method effectively to solve linear programming problems, interpreting solutions graphically and understanding the geometric interpretation of optimization.
2. Students will demonstrate proficiency in applying the simplex method to solve linear programming problems, understanding the algorithm's steps and interpreting the results.
3. Students will gain an understanding of duality in linear programming and be able to find the dual of a given LPP, enhancing their ability to analyze optimization problems from multiple perspectives.
4. Students will develop the skills to find initial basic feasible solutions for transportation problems, enabling them to set up the optimization process effectively.
5. Students will demonstrate competency in analyzing optimality tests for transportation problems, understanding the criteria for determining when a solution is optimal and interpreting the results accurately.
6. Students will gain proficiency in obtaining solutions for both balanced and unbalanced assignment problems, enhancing their ability to assign tasks or resources optimally in various real-world scenarios.

Catalog Description

· Understand how to find the formulation solution of LPP having more than three variable
· Learn how to find IBFS and optimal of transportation problem by MATLAB.
· Understand how to solve balanced and unbalanced Assignment problem by MATLAB.

Course Content

List of practical

1. Investigate the Solution of LPP problem by Graphical method
2. To Solve the LPP problem simplex method.
3. Find the dual of simplex method
4. Investigate and find the initial basic feasible solution of the transportation problem
5. Analyse the Optimality test for transportation problem
6. To Obtain the solution of balanced and unbalanced assignment Problem.

Reference Books

1. Lisa Oberbroeckling, Programming Mathematics Using MATLAB, Academic Press
2. Kanti Swarup, P.K. Gupta and Manmohan, Operations Research, Sultan Chand & Sonsv

BSMA121A	CALCULUS	L	T	P	C
		4	0	0	4

Course Objectives:

1. To understand the concepts of sequences and series, including convergence, boundedness, and monotonicity, and to apply these concepts to solve problems involving sequences and series.
2. To develop proficiency in integration techniques, including the definite integral as a limit of sums, integration of irrational algebraic and transcendental functions, and the use of reduction formulae.
3. To comprehend the notions of limit and continuity for real-valued functions, including the ε-δ definition of limits, limits at infinity, continuity, and types of discontinuity, and to apply these concepts in the analysis of functions.
4. To explore the concepts of differentiability and successive differentiation, including the relationship between differentiability and continuity, and to apply differentiation rules and mean value theorems in various contexts, including curve tracing and optimization problems.

Course Learning Outcomes:

1. Students will be able to analyze and determine convergence properties of sequences and series, and apply techniques for determining boundedness and monotonicity, enabling them to solve problems involving sequences and series.
2. Students will develop proficiency in integration techniques, including the evaluation of definite integrals and the use of reduction formulae, enabling them to compute integrals of various functions accurately.
3. Students will demonstrate an understanding of limit and continuity concepts, including the ε-δ definition of limits and the properties of continuous functions, enabling them to analyze and interpret the behavior of functions in various contexts.
4. Students will gain proficiency in differentiation techniques, including the application of differentiation rules and mean value theorems, enabling them to analyze curves, identify critical points, and solve optimization problems effectively.

Catalog Description

Calculus is a transition course to upper-division mathematics and computer science courses. Students will extend their experience with functions as they study the fundamental concepts of calculus: limiting behaviors, derivatives, optimization, related rates, graphing and other applications of derivatives. Important objectives of the calculus sequence are to develop and strengthen the students' problem-solving skills and to teach them to read, write, speak, and think in the language of mathematics. In particular, students learn how to apply the tools of calculus to a variety of problem situations.

Course Content

Unit I: **14 lecture hours**

Sequences and Integration: Real numbers, Sequences of real numbers, Convergence of sequences and series, Bounded and monotonic sequences; Definite integral as a limit of sum, Integration of irrational algebraic functions and transcendental functions, Reduction formulae, Definite integrals.

Unit II: **15 lecture hours**

Limit and Continuity: $\epsilon - \delta$ definition of limit of a real valued function, Limit at infinity and infinite limits; Continuity of a real valued function, Properties of continuous functions, Intermediate value theorem, Geometrical interpretation of continuity, Types of discontinuity; Uniform continuity.

Unit III: **17 lecture hours**

Differentiability: Differentiability of a real valued function, Geometrical interpretation of differentiability, Relation between differentiability and continuity, Differentiability and monotonicity, Chain rule of differentiation; Darboux's theorem, Rolle's theorem, Lagrange's mean value theorem, Cauchy's mean value theorem, Geometrical interpretation of mean value theorems; Successive differentiation, Leibnitz's theorem.

Expansions of Functions: Maclaurin's and Taylor's theorems for expansion of a function in an infinite series, Taylor's theorem in finite form with Lagrange, Cauchy and Roche–Schlomilch forms of remainder; Maxima and minima.

Unit IV: **14 lecture hours**

Curvature, Asymptotes and Curve Tracing: Curvature; Asymptotes of general algebraic curves, Parallel asymptotes, Asymptotes parallel to axes; Symmetry, Concavity and convexity, Points of inflection, Tangents at origin, Multiple points, Position and nature of double points; Tracing of Cartesian, polar and parametric curves.

Textbooks

1. Gorakh Prasad (2016). *Differential Calculus* (19th edition). Pothishala Pvt. Ltd

Reference Books/Materials

1. Howard Anton, I. Bivens & Stephan Davis (2016). *Calculus* (10th edition). Wiley India.
2. Gabriel Klambauer (1986). *Aspects of Calculus*. Springer-Verlag.
3. WieslawKrawcewicz&Bindhyachal Rai (2003). *Calculus with Maple Labs*. Narosa.
4. George B. Thomas Jr., Joel Hass, Christopher Heil & Maurice D. Weir (2018). *Thomas*' *Calculus* (14thedition). Pearson Education.

BSMA171A	CALCULUS LAB	L	T	P	C
		0	0	4	2

Course Objectives:

1. To develop proficiency in plotting and analyzing graphs of exponential, logarithmic, rational, trigonometric, and inverse trigonometric functions, understanding the effect of parameters on their graphs.
2. To enhance graphical skills by plotting graphs of polynomials of degree 4 and 5, facilitating the visualization of polynomial behavior and characteristics.
3. To understand and apply the concepts of limits and derivatives to the functions studied, enabling students to analyze the behavior of functions at specific points and understand their rates of change.
4. To introduce students to parametric curves, such as trochoids, cycloids, and hypocycloids, and to enable them to sketch these curves accurately, understanding their parametric representations and geometric properties.
5. To explore the concept of surface of revolution, enabling students to understand the generation of surfaces by rotating curves around axes and to apply this concept to various curve types.

Course Learning Outcomes:

1. Students will be able to plot and analyze graphs of exponential, logarithmic, rational, trigonometric, and inverse trigonometric functions, and understand how changes in parameters affect their graphs.
2. Students will develop graphical skills in plotting and analyzing graphs of polynomials of degree 4 and 5, gaining insight into polynomial behavior and characteristics such as roots, turning points, and end behavior.
3. Students will demonstrate proficiency in calculating limits and derivatives of functions studied, enabling them to analyze function behavior at specific points and understand rates of change.
4. Students will gain the ability to sketch parametric curves accurately, understanding their parametric representations and geometric properties, and recognizing their shapes

and characteristics.

5. Students will understand the concept of surface of revolution and be able to generate surfaces by rotating curves around axes, applying this concept to various curve types and gaining insight into the geometric properties of resulting surfaces.

Catalog Description

The purpose of these labs is to help students talk and write in meaningful ways about mathematics. Specifically to describe quantities and changes in quantities clearly in terms of context, to make rigorous arguments about how such quantities are related, and to make connections between these features in the contexts and on graphs

Course Content

List of practical

- Plotting the graphs of the functions $exp(ax+b), log(ax + b), \frac{1}{ax+b}, sin(ax + b), cos(ax + b),$ and to illustrate the effect of a and b on the graph.
- Plotting the graphs of the polynomial of degree 4 and 5.
- Calculate the limit and derivative of above function.
- Sketching parametric curves (eg. Trochoid, cycloid, hypocycloid).
- Obtaining surface of revolution of curves.
- Tracing of conics in Cartesian coordinates/polar coordinates.
- Sketching ellipsoid, hyperboloid of one and two sheets (using Cartesian co-ordinates)

Textbooks

3. Lisa Oberbroeckling, Programming Mathematics Using MATLAB, Academic Press
4. Ronald L. Lipsman, Jonathan M. Rosenberg, Calculus with MATLAB: With Applications to Geometry and Physics, Springer International Publishing.

BSMA124A	**ORDINARY DIFFERENTIAL EQUATIONS**	**L**	**T**	**P**	**C**
		4	**0**	**0**	**4**

Course Objectives:

1. To understand the basic concepts and genesis of ordinary differential equations, including the order and degree of differential equations, and their classification.

2. To explore methods for solving first-order differential equations, including separation of variables, homogeneous equations, exact equations, and integrating factors, and to understand their applications.

3. To study second-order linear differential equations with variable coefficients, including solutions of homogeneous equations with constant coefficients, and methods such as

variation of parameters and undetermined coefficients.

4. To examine higher-order linear differential equations, including principles of superposition, linear independence of solutions, Wronskian, and methods for solving homogeneous and non-homogeneous equations with constant coefficients.

Course Learning Outcomes:

1. Students will be able to classify and analyze ordinary differential equations based on their order and degree, and apply appropriate solution methods.
2. Students will develop proficiency in solving first-order differential equations using various techniques, including separation of variables and integrating factors, and understand their practical significance.
3. Students will demonstrate competency in solving second-order linear differential equations with variable coefficients, employing methods such as variation of parameters and undetermined coefficients, and analyze their solutions.
4. Students will gain an understanding of higher-order linear differential equations and their solutions, including principles of superposition, linear independence, and methods such as variation of parameters and undetermined coefficients, enabling them to solve complex differential equations and analyze their behavior.

Catalog Description

In this introductory course on Ordinary Differential Equations, we first provide basic terminologies on the theory of differential equations and then proceed to methods of solving various types of ordinary differential equations. We handle first and second order differential equations and then higher order linear differential equations. The course demonstrates the usefulness of ordinary differential equations for modelling physical, biological, financial or economic problems. The ability to predict the way in which these systems evolve or behave is determined by modelling these systems and find solutions of the equations explicitly or approximately. The course includes complementary mathematical approaches for their solution, including analytical methods, graphical analysis and numerical techniques. A significant part of the course is emphasis on solving linear systems with computer software as a mathematical tool.

Course Content

UNIT-I **14 Lectures**

First Order Differential Equations: Basic concepts and genesis of ordinary differential equations, Order and degree of a differential equation, Differential equations of first order and first degree, Equations in which variables are separable, Homogeneous equations, Linear differential equations and equations reducible to linear form, Exact differential equations, Integrating factor, First order higher degree equations solvable for x, y and p. Clairaut's form and singular solutions. Picard's method of successive approximations and the statement of Picard's theorem for the existence and uniqueness of the solutions of the first order differential equations.

UNIT-II **14 Lectures**

Second Order Linear Differential Equations: Statement of existence and uniqueness theorem for linear differential equations, General theory of linear differential equations of second order with variable coefficients, Solutions of homogeneous linear ordinary differential equations of second order with constant coefficients, Transformations of the equation by changing the dependent/independent variable, Method of variation of parameters and method of undetermined coefficients, Reduction of order, Coupled linear differential equations with constant coefficients.

UNIT-III **17 Lectures**

Higher Order Linear Differential Equations: Principle of superposition for a homogeneous linear differential equation, Linearly dependent and linearly independent solutions on an interval, Wronskian and its properties, Concept of a general solution of a linear differential equation, Linear homogeneous and non-homogeneous equations of higher order with constant coefficients, Euler-Cauchy equation, Method of variation of parameters and method of undetermined coefficients, Inverse operator method.

UNIT-IV **15 Lectures**

Series Solutions of Differential Equations: Power series method, Legendre's equation, Legendre polynomials, Rodrigue's formula, Orthogonality of Legendre polynomials, Frobenius method, Bessel's equation, Bessel functions and their properties, Recurrence relations.

Applications: Orthogonal trajectories, Acceleration-velocity model, Minimum velocity of escape from Earth's gravitational field, Growth and decay models, Malthusian and logistic population models, Radioactive decay, Drug assimilation into the blood of a single cold pill; Free and forced mechanical oscillations of a spring suspended vertically carrying a mass at its lowest tip, Phenomena of resonance, LCR circuits, Lotka-Volterra population model.

Reference Books/Materials

1. Belinda Barnes & Glenn Robert Fulford (2015). *Mathematical Modelling with Case Studies***:** *A Differential Equation Approach Using* Maple *and* MATLAB (2nd edition).

Chapman & Hall/CRC Press, Taylor & Francis.

2. H. I. Freedman (1980). *Deterministic Mathematical Models in Population Ecology*. Marcel Dekker Inc.

3. Erwin Kreyszig (2011). *Advanced Engineering Mathematics* (10th edition). Wiley.

4. Daniel A. Murray (2003). *Introductory Course in Differential Equations*, Orient.
5. B. Rai, D. P. Choudhury & H. I. Freedman (2013). *A Course in Ordinary Differential Equations* (2nd edition). Narosa.
6. Shepley L. Ross (2007). *Differential Equations* (3rd edition), Wiley India.
7. George F. Simmons (2017). *Differential Equations with Applications and Historical Notes* (3rd edition). CRC Press. Taylor & Francis.

		L	T	P	C
BSMA174A	**ORDINARY DIFFERENTIAL EQUATIONS LAB**	**0**	**0**	**4**	**2**

Course Objectives:

1. To develop proficiency in solving and plotting solution families of second-order differential equations, enhancing skills in mathematical modeling and analysis.
2. To expand understanding of differential equations by solving and plotting solution families of third-order equations, strengthening problem-solving abilities in mathematical modeling.
3. To explore growth models, focusing on exponential growth cases, to understand the principles of population dynamics and mathematical modeling.
4. To examine decay models, emphasizing exponential decay cases, to comprehend the principles of decay processes and their mathematical representations.

Course Learning Outcomes:

1. Students will be able to solve and plot solution families of second-order differential equations, demonstrating proficiency in mathematical modeling and analysis techniques.
2. Students will develop the ability to solve and plot solution families of third-order differential equations, enhancing problem-solving skills in advanced mathematical modeling.
3. Students will gain an understanding of growth models, particularly exponential growth cases, enabling them to analyze population dynamics and predict growth patterns.
4. Students will demonstrate comprehension of decay models, focusing on exponential decay cases, and be able to analyze decay processes and their implications in various contexts.

Catalog Description

The aim of this course is to learn theory of ordinary differential equations and solution methods. Use knowledge of Ordinary Differential Equations (ODEs), modelling, the general structure of solutions, and analytic and numerical methods for solution. Nature of ODEs.. After completion of the course, the students will be able to solve the ODEs independently. They can solve PDEs in higher dimension. Convert ordinary differential equations to canonical form.

Course Content

List of practical

1. Plotting of second order solution family of differential equation.
2. Plotting of third order solution family of differential equation.
3. Growth model (exponential case only).
4. Decay model (exponential case only).
5. Lake pollution model
6. Case of single cold pill and a course of cold pills.
7. Limited growth of population (with and without harvesting).
8. Predatory-prey model (basic volterra model)
9. Basic Epidemic model of influenza
10. Basic Battle model

NOTE: Ten experiments are to be performed, out of which at least seven experiments should be performed from above list. Remaining three experiments may either be performed from the above list or designed & setup by the concerned person as per the scope of the syllabus.

BSCH141A	Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Hydrocarbons	L	T	P	C
		4	0	0	**4**

Course Objectives:

1. To comprehend the principles of atomic structure, including quantum mechanics and its application to understanding the behavior of electrons in atoms.
2. To understand the various types of chemical bonds, such as ionic and covalent bonding, and their implications for the stability and properties of compounds.
3. To explore the fundamentals of organic chemistry, including electronic displacements, reaction intermediates, and stereochemistry.
4. To study the properties and reactions of aliphatic hydrocarbons, focusing on their preparation methods and chemical transformations.

Course Learning Outcomes:

1. Students will be able to analyze atomic structure using quantum mechanics principles, including Schrödinger equation, quantum numbers, and atomic orbitals, to predict electron behavior and explain atomic properties.
2. Students will demonstrate an understanding of chemical bonding theories, including ionic and covalent bonding, and apply concepts such as lattice energy, solvation energy, and Fajan's rules to predict and explain the properties of compounds.
3. Students will develop the ability to identify and analyze organic chemistry concepts, including electronic displacements, reaction mechanisms, and stereochemistry, enhancing their understanding of organic reactions and molecular behavior.
4. Students will gain practical knowledge of the properties and reactions of aliphatic hydrocarbons, including preparation methods and chemical transformations, enabling them to apply this knowledge in organic synthesis and functional group transformations.Section A: Inorganic Chemistry

Course Content

Unit I

Atomic Structure

Review of: Bohr's theory and its limitations, Heisenberg uncertainty principle, Dual behaviour of matter and radiation, De-Broglie's relation, Hydrogen atom spectra, need of a new approach to atomic structure.

What is Quantum mechanics? Time independent Schrodinger equation and meaning of various terms in it. Significance of ψ and ψ^2, Schrödinger equation for hydrogen atom, radial and angular parts of the hydogenic wave functions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals (Only graphical representation), radial and angular nodes and their significance, radial distribution functions and the concept of the most probable distance with special reference to 1s and 2s atomic orbitals. Significance of quantum numbers, orbital angular momentum and quantum numbers m_l and m_s. Shapes of s, p and d atomic orbitals, nodal planes, discovery of spin, spin quantum number (s) and magnetic spin quantum number (m_s).

Rules for filling electrons in various orbitals, electronic configurations of the atoms, stability of half-filled and completely filled orbitals, concept of exchange energy, relative energies of atomic orbitals, anomalous electronic configurations.

Unit II

Chemical Bonding and Molecular Structure

Ionic Bonding: General characteristics of ionic bonding, energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds, statement of Born-Landé equation for calculation of lattice energy (no derivation), Born- Haber cycle and its applications, covalent character in ionic compounds, polarizing power and polarizability, Fajan's rules. Ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.

Covalent bonding: VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR (H_2O, NH_3, PCl_5, SF_6, ClF_3, SF_4) and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements.

Concept of resonance and resonating structures in various inorganic and

organic compounds.

MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for s- s, s-p and p-p combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of s-p mixing) and heteronuclear diatomic molecules such as CO, NO and NO^+.

Section B: Organic Chemistry (Lectures:30)

Unit III Fundamentals of Organic Chemistry

Electronic displacements: Inductive effect, electromeric effect, resonance, hyperconjugation. Cleavage of bonds: homolysis and heterolysis. Reaction intermediates: carbocations, carbanions and free radicals. Electrophiles and nucleophiles, Aromaticity: benzenoids and Hückel's rule.

Stereochemistry

Conformations with respect to ethane, butane and cyclohexane, interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations, concept of chirality (upto two carbon atoms). configuration: geometrical and optical isomerism; enantiomerism, diastereomerism and meso compounds). Threo and erythro; D and L; *cis - trans* nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z nomenclature (for upto two C=C systems).

Unit IV Aliphatic Hydrocarbons

Functional group approach for the following reactions: preparations, physical property & chemical reactions to be studied with mechanism in context to their structure.

Alkanes:

Preparation: catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, Grignard reagent. Reactions: Free radical substitution: Halogenation.

Alkenes:

Preparation: Elimination reactions: Dehydration of alcohols and dehydrohalogenation of alkyl halides (Saytzeff's rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction).

Reactions: cis-addition (alk. $KMnO_4$) and trans-addition (bromine), addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, oxymecuration-demercuration, Hydroboration- oxidation.

Alkynes:

Preparation: Acetylene from CaC_2 and conversion into higher alkynes; by dehalogenation of tetrahalides and dehydrohalogenation of vicinal-dihalides.

Reactions: formation of metal acetylides and acidity of alkynes, addition of bromine and alkaline $KMnO_4$, ozonolysis and oxidation with hot alk. $KMnO_4$. Hydration to form carbonyl compounds.

Reference books:

1. Lee., J. D.(2010),**A new Concise Inorganic Chemistry**, Pearson Education.
2. Huheey, J.E.; Keiter, E.; Keiter, R. (2009),**Inorganic Chemistry: Principles of Structure and Reactivity**, Pearson Publication.
3. Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M.T.; Armstrong, F.A.(2010),**Shriver and Atkin's Inorganic Chemistry**, Oxford
4. Sykes, P.(2005), **A Guide Book to Mechanism in Organic Chemistry**, Orient Longman.
5. Eliel, E. L. (2000), **Stereochemistry of Carbon Compounds**, Tata McGraw Hill.
6. Morrison, R. N.; Boyd, R. N. **Organic Chemistry**, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
7. Bahl, A; Bahl, B. S. (2012), **Advanced Organic Chemistry**, S. Chand.

		L	T	P	C
BSCH161A	**Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Hydrocarbons Lab**	0	0	4	**2**

Course Objectives:

1. Develop proficiency in volumetric analysis techniques for the quantitative determination of various inorganic compounds and ions.
2. Enhance practical skills in organic compound purification methods and criteria for assessing purity.
3. Familiarize students with chromatographic separation techniques and their applications in organic compound analysis.
4. Provide hands-on experience in identifying and separating components of complex mixtures using chromatography.

Course Learning Outcomes:

1. Upon completion of the course, students will be able to accurately perform volumetric analyses to determine the concentrations of various inorganic compounds, including oxalic acid, Mohr's salt, Fe (II) ions, and Cu (II) ions, demonstrating proficiency in quantitative analytical techniques.
2. Students will demonstrate competency in organic compound purification methods such as crystallization and distillation, and be able to assess the purity of compounds based on melting and boiling point determinations, ensuring high-quality sample preparation for further analysis.
3. Through practical exercises and experimentation, students will develop skills in chromatographic separation techniques, including measuring Rf values and

interpreting chromatograms, enabling them to separate and identify components of complex mixtures accurately.

4. By applying radial/ascending paper chromatography to identify and separate amino acids and sugars, students will demonstrate their ability to apply chromatographic methods effectively to analyze and characterize organic compounds, thereby enhancing their understanding of separation techniques in organic chemistry.

Course Content

Section A: Inorganic Chemistry - Volumetric Analysis

1. Estimation of oxalic acid by titrating it with $KMnO_4$.
2. Estimation of Mohr's salt by titrating it with $KMnO_4$.
3. Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$.
4. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ using internal indicator.
5. Estimation of Cu (II) ions iodometrically using $Na_2S_2O_3$.

Section B: Organic Chemistry

1. Purification of organic compound by crystallisation (from water and alcohol) and distillation.
2. Criteria of purity: Determination of M.P./B.P.
3. Separation of mixtures by chromatography: Measure the Rf value in each case (combination of two compounds to be given)

b) Identify and separate the components of a given mixture of 2 amino acids (glycine, aspartic acid, glutamic acid, tyrosine or any other amino acid) by radial/ascending paper chromatography.

c) Identify and separate the sugars present in the given mixture by radial/ascending paper chromatography.

Practical:

1. Jeffery, G.H.; Bassett, J.; Mendham, J.; Denney, R.C.(1989),**Vogel's Textbook of Quantitative Chemical Analysis,** 5th Edn.**,** John Wiley and Sons Inc,.
2. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. (2012),**Vogel's Textbook ofPractical Organic Chemistry**, Pearson.
3. Mann, F.G.; Saunders, B.C.(2009),**Practical Organic Chemistry**, Pearson Education.

BSCH142A	Chemical Energetics, Equilibria and Functional Group Organic Chemistry-I	L	T	P	C
		4	0	0	**4**

Course Objectives:

1. To provide a comprehensive understanding of thermodynamics and its application in chemical processes, including thermochemistry, standard enthalpies of formation, and bond energies.
2. To elucidate the principles of chemical equilibrium, including the relationship between free energy change and equilibrium constant, and the application of Le Chatelier's principle.
3. To familiarize students with the concept of ionic equilibria, including the behavior of strong, moderate, and weak electrolytes, factors affecting ionization, and the calculation of pH for various solutions.
4. To introduce students to the structural features and reactions of aromatic hydrocarbons, alcohols, phenols, ethers, aldehydes, and ketones, emphasizing their preparation methods and chemical properties.

Course Learning Outcomes:

1. Students will be able to apply thermodynamic principles to calculate standard enthalpies of formation, bond energies, and variation of enthalpy with temperature, facilitating the quantitative analysis of chemical reactions.
2. Students will develop a deep understanding of chemical equilibrium, enabling them to predict the direction and extent of reactions based on changes in conditions and equilibrium constants.
3. Students will acquire proficiency in the analysis of ionic equilibria, including the calculation of pH, degree of ionization, and hydrolysis constants for various salts, enhancing their ability to interpret and manipulate chemical solutions.
4. Students will demonstrate competency in the synthesis and characterization of organic compounds, including aromatic hydrocarbons, alcohols, phenols, ethers, aldehydes, and ketones, and understand the underlying mechanisms of their reactions, enabling them to apply this knowledge in organic synthesis and functional group transformations.Section A: Physical Chemistry

Course Content

Unit I

Chemical Energetics

Review of thermodynamics and the laws of thermodynamics, important principles and definitions of thermochemistry, concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution, calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data, variation of enthalpy of a reaction with temperature – Kirchhoff's equation., statement of third law of thermodynamics and calculation of absolute entropies of substances.

Chemical Equilibrium

Free energy change in a chemical reaction, Thermodynamic derivation of the law of chemical equilibrium, distinction between G and Go, Le Chatelier's principle, relationships between Kp, Kc and Kx for reactions involving ideal gases.

Unit II

Ionic Equilibria

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, Ostwald's dilution law, ionization constant and ionic product of water, ionization of weak acids and bases, pH scale, common ion effect, salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions,Henderson-Hasselbach equation.Solubility and solubility product of sparingly soluble salts – applications of solubility product principle

Section B: Organic Chemistry

Unit III Aromatic Hydrocarbons

Structure and aromatic character of benzene.

Preparation**:** methods of preparation of benzene from phenol, benzoic acid, acetylene and benzene sulphonic acid.

Reactions**:** electrophilic substitution reactions in benzene citing examples of nitration, halogenation, sulphonation and Friedel-Craft's alkylation and acylation with emphasis on carbocationic rearrangement, side chain oxidation of alkyl benzenes.

UNIT IV

Alcohols, Phenols, Ethers, Aldehydes and Ketones (Aliphatic and Aromatic)

A) Alcohols (upto 5 Carbon):
Structure and classification of alcohols as 1º, 2º & 3º.

Preparation: Methods of preparation of 1º, 2º & 3º by using Grignard reagent, ester hydrolysis and reduction of aldehydes, ketones, carboxylic acids and esters.

Reactions: Acidic character of alcohols and reaction with sodium, with HX (Lucas Test), esterification, oxidation (with PCC, alkaline $KMnO_4$, acidic $K_2Cr_2O_7$ and conc. HNO_3), Oppeneauer Oxidation.

B) Diols (upto 6 Carbons): Oxidation and Pinacol-Pinacolone rearrangement.
C) Phenols: acidity of phenols and factors affecting their acidity.
Preparation: Methods of preparation from cumene, diazonium salts and benzene sulphonic acid.

Reactions: Directive influence of OH group and Electrophilic substitution reactions, viz. nitration, halogenation, sulphonation, Reimer-Tiemann reaction, Gattermann–Koch reaction, Houben-Hoesch condensation, reaction due to OH group: Schotten-Baumann reaction

D) Ethers (Aliphatic & Aromatic):
Williamson's ether synthesis, Cleavage of ethers with HI

E) Aldehydes and ketones (Aliphatic and Aromatic):
Preparation: from acid chlorides and from nitriles.

Reactions: Nucleophilic addition, nucleophilic addition – elimination reaction including reaction with HCN, ROH, $NaHSO_3$, NH_2-G derivatives. Iodoform test, Aldol Condensation, Cannizzaro's reaction, Wittig reaction, Benzoin condensation. Clemmensen reduction, Wolff Kishner reduction, Meerwein-Pondorff Verley reduction.

Reference books:

Theory:

1. Castellan, G. W. (2004),**Physical Chemistry**, Narosa.
2. Kapoor, K.L. (2015),**A Textbook of Physical Chemistry**,Vol 1, 6th Edition, McGraw Hill Education.
3. Kapoor, K.L.(2015), **A Textbook of Physical Chemistry**, Vol 2, 6th Edition,McGraw Hill Education.
4. B.R.Puri, L.R.Sharma, M.S.Pathania, (2017),**Principles of Physical Chemistry**, Vishal Publishing Co.
5. Finar, I. L. **Organic Chemistry** (Volume 1 & 2), Dorling Kindersley (India)

Pvt. Ltd. (Pearson Education).
6. Morrison, R. N.; Boyd, R. N. **Organic Chemistry**, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
7. Bahl, A; Bahl, B. S. (2012), **Advanced Organic Chemistry**, S. Chand.

BSCH162A	Chemical Energetics, Equilibria and Functional Group Organic Chemistry-I Lab	L	T	P	C
		0	0	4	**2**

Course Objectives:

1. To familiarize students with calorimetry techniques and enable them to determine the heat capacity of a calorimeter.
2. To provide students with hands-on experience in determining the enthalpy of neutralization of a strong acid with a strong base.
3. To enable students to determine the integral enthalpy of solution for salts such as KNO3 and NH4Cl.
4. To facilitate students' understanding of enthalpy changes associated with the hydration process through the determination of the enthalpy of hydration of copper sulphate.

Course Learning Outcomes:

1. Students will be able to accurately determine the heat capacity of a calorimeter and understand its significance in calorimetry experiments.
2. Students will gain proficiency in experimental techniques for determining enthalpy changes, specifically the enthalpy of neutralization of acids and bases.
3. Students will develop skills in conducting experiments to determine the integral enthalpy of solution for different salts, enhancing their understanding of solution thermodynamics.
4. Students will acquire practical experience in measuring enthalpy changes associated with hydration reactions, thereby reinforcing their comprehension of energetics in chemical processes.

Course Content

Practical: Section A: Physical Chemistry Energetics:

1. Determination of heat capacity of calorimeter.

2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
3. Determination of integral enthalpy of solution of salts (KNO_3, NH_4Cl).
4. Determination of enthalpy of hydration of copper sulphate.

Ionic equilibria:

1. Preparation of buffer solutions: (i) Sodium acetate-acetic acid or (ii) Ammonium chloride-ammonium acetate. Measurement of the pH of buffer solutions and comparison of the values with theoretical values.

Section B: Organic Chemistry

Preparations: (Mechanism of various reactions involved to be discussed)

(Recrystallization, determination of melting point and calculation of quantitative yields to be done in all cases)

2. Bromination of phenol/aniline
3. Benzoylation of amines/phenols
4. Oxime of aldehydes and ketones
5. 2,4-dinitrophenylhydrazone of aldehydes and ketones
6. Semicarbazone of aldehydes and ketones

Practical:

1. Khosla, B.D.; Garg, V.C.;Gulati, A.(2015),**Senior Practical Physical Chemistry**, R. Chand & Co.
2. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. (2012),**Vogel's Textbook ofPractical Organic Chemistry**, Pearson.
3. Mann, F.G.; Saunders, B.C. (2009),**Practical Organic Chemistry**, Pearson Education.

BSCH241A	Solutions, Phase Equilibrium, Conductance, Electrochemistry and Functional Group Organic Chemistry-II	L	T	P	C
		4	0	0	**4**

Course Objectives:

1. Understand the thermodynamic principles governing the behavior of ideal and non-ideal solutions, including Raoult's law and deviations from it.

2. Analyze phase equilibria in complex systems, utilizing Gibbs phase rule and phase diagrams to predict equilibrium conditions.

3. Investigate the electrical properties of solutions, including conductivity, transference numbers, and their variations with concentration.

4. Apply conductometric methods to determine various chemical parameters such as degree of ionization, solubility products, and hydrolysis constants.

Course Learning Outcomes:

1. Demonstrate proficiency in analyzing and predicting the behavior of ideal and non-ideal solutions based on their composition and temperature.

2. Interpret phase diagrams and predict phase equilibria in one and two-component systems involving eutectics, congruent and incongruent melting points.

3. Apply principles of conductivity to quantitatively analyze electrolyte solutions, determining parameters such as degree of ionization and solubility products.

4. Utilize conductometric titrations to accurately determine acid-base reactions and other chemical parameters in solution chemistry.

Course Content

Section A: Physical Chemistry

UNIT I Solutions

Thermodynamics of ideal solutions: Ideal solutions and Raoult's law, deviations from Raoult's law- non- ideal solutions. Vapour pressure, composition and temperature-composition curves of ideal and non-ideal solutions. Distillation of solutions, Lever rule, Azeotropes. Partial miscibility of liquids: Critical solution temperature; effect of impurity on partial miscibility of liquids. Immiscibility of liquids: principle of steam distillation, Nernst distribution law and its applications, solvent extraction.

Phase Equilibrium

Phases, components and degrees of freedom of a system, criteria of phase equilibrium, Gibbs phase rule and its thermodynamic derivation, derivation of Clausius-Clapeyron equation and its importance in phase equilibria, phase diagrams of one component systems (water and sulphur) and two component systems involving eutectics, congruent and incongruent melting points (lead-silver, $FeCl_3$-H_2O and Na-K only).

UNIT II Conductance

Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes, Kohlrausch Law of independent migration of ions, transference number and its experimental determination using Hittorf and moving boundary methods, Ionic mobility, applications of conductance measurements:

determination of degree of ionization of weak electrolytes, solubility and solubility products of sparingly soluble salts, ionic product of water, hydrolysis constant of a salt. Conductometric titrations (only acid-base).

Electrochemistry

Reversible and irreversible cells, concept of EMF of a cell, measurement of EMF of a cell, Nernst equation and its importance, types of electrodes, standard electrode potential, electrochemical series. thermodynamics of a reversible cell, calculation of thermodynamic properties: G, H and S from EMF data. Calculation of equilibrium constant from EMF data, concentration cells with transference and without transference, liquid junction potential and salt bridge, pH determination using hydrogen electrode and quinhydrone electrode, Potentiometric titrations-qualitative treatment (acid-base and oxidation-reduction only).

Section B: Organic Chemistry (Lectures:30)

UNIT III

Functional group approach for the following reactions: Preparations, physical & chemical properties to be studied in context to their structure with mechanism.

A) *Carboxylic acids and their derivatives (aliphatic and aromatic)*
Preparation: Acidic and alkaline hydrolysis of esters. Reactions: Hell-Volhard Zelinsky reaction, acidity of carboxylic acids, effect of substitution on acid strength.

Carboxylic acid derivatives (aliphatic):

Preparation: Acid chlorides, anhydrides, esters and amides from acids and their interconversion, Claisen condensation.

Reactions: Relative reactivities of acid derivatives towards nucleophiles, Reformatsky reaction, Perkin condensation.

B) *Amines (aliphatic & aromatic) and Diazonium Salts*
Amines

Preparation: from alkyl halides, Gabriel's Phthalimide synthesis, Hofmann Bromamide reaction.

Reactions: Hofmann vs Saytzeff elimination, carbylamine test, Hinsberg test, reaction with HNO_2, Schotten-Baumann reaction. Electrophilic substitution (case aniline): nitration, bromination, sulphonation, basicity of amines.

Diazonium salt

Preparation: from aromatic amines

Reactions: conversion to benzene, phenol and dyes.

UNIT IV Amino Acids, Peptides and Proteins

Zwitterion, isoelectric point and electrophoresis

Preparation of amino acids: Strecker synthesis and using Gabriel's phthalimide synthesis.

Reactions of amino acids: ester of –COOH group, acetylation of $–NH_2$ group, complexation with Cu^{2+} ions, ninhydrin test.

Overview of Primary, Secondary, Tertiary and Quaternary Structure of proteins.

Determination of primary structure of peptides by degradation Edmann degradation (N- terminal) and C– terminal (thiohydantoin and with carboxypeptidase enzyme). Synthesis of simple peptides (upto dipeptides) by N-protection (t-butyloxycarbonyl and phthaloyl) & C- activating groups and Merrifield solid- phase synthesis.

B) Carbohydrates

Classification, and general properties, glucose and fructose (open chain and cyclic structure), determination of configuration of monosaccharides, absolute configuration of glucose and fructose, mutarotation, ascending and descending in monosaccharides. Structure of disaccharides (sucrose, cellobiose, maltose, lactose) and polysaccharides (starch and cellulose) excluding their structure elucidation.

Reference books:

1. Castellan, G.W. (2004),**Physical Chemistry**, Narosa.
2. Kapoor, K.L. (2015),**A Textbook of Physical Chemistry**,Vol 1, 6th Edition, McGraw Hill Education.
3. Kapoor, K.L. (2013),**A Textbook of Physical Chemistry**,Vol 3, 3rd Edition, McGraw Hill Education.
4. B.R.Puri, L.R.Sharma, M.S.Pathania, (2017),**Principles of Physical Chemistry**, Vishal

   Publishing Co.

5. Morrison, R. N.; Boyd, R. N. **Organic Chemistry**, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
6. Finar, I. L. **Organic Chemistry** (Volume 1 & 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

<table>
<tr><td rowspan="2">BSCH267A</td><td rowspan="2">Solutions, Phase Equilibrium, Conductance, Electrochemistry and Functional Group Organic Chemistry-II Lab</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>0</td><td>0</td><td>4</td><td>2</td></tr>
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Course Objectives:

1. To understand the principles of phase equilibria and apply them to construct phase diagrams of binary systems, particularly focusing on simple eutectic systems using cooling curves.
2. To investigate the critical solution temperature and composition of a binary system, such as the phenol-water system, and analyze the effects of impurities on phase behavior.
3. To learn experimental techniques in conductance measurement, including determining cell constants, equivalent conductance, degree of dissociation, and dissociation constants of weak acids, and performing conductometric titrations.
4. To explore potentiometric titration techniques and apply them in the determination of acid-base reactions, including strong acid vs. strong base and weak acid vs. strong base titrations.

Course Learning Outcomes:

1. Students will demonstrate proficiency in constructing phase diagrams for binary systems, understanding the significance of eutectic points, and interpreting phase behavior using experimental cooling curves.
2. Students will acquire skills in determining critical solution temperatures and compositions of binary systems, analyzing the impact of impurities on phase equilibria, and applying these concepts to real-world scenarios.
3. Students will develop practical laboratory skills in conductance measurement, including determining cell constants and conducting conductometric titrations, and interpret experimental results to determine dissociation constants and degree of dissociation.
4. Students will demonstrate competency in potentiometric titration techniques, including performing titrations of strong and weak acids with strong bases, and interpreting potentiometric curves to determine equivalence points and analyze acid-base reactions qualitatively.

Course Content

Section A: Physical Chemistry Phase Equilibria

1. Construction of the phase diagram of a binary system (simple eutectic) using cooling curves.
2. Determination of critical solution temperature and composition of phenol water system and study the effect of impurities on it.

Conductance

1. Determination of cell constant.
2. Determination of equivalent conductance, degree of dissociation and dissociation constant of a weak acid.
3. Perform the following conductometric titrations:
   a) Strong acid vs strong base
   b) Weak acid vs strong base.

Potentiometry

Perform the potentiometric titrations of (i) Strong acid vs strong base and (ii) Weak acid vs strong base.

Section B: Organic Chemistry

Systematic qualitative analysis of organic compounds possessing monofunctional groups (Alcohols, Phenols, Carbonyl, -COOH). (Including Derivative Preparation).

Practical:

1. Khosla, B.D.; Garg, V.C.;Gulati, A.(2015),**Senior Practical Physical Chemistry**, R. Chand & Co.
2. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. (2012),**Vogel's Textbook ofPractical Organic Chemistry**, Pearson.
3. Mann, F.G.; Saunders, B.C. (2009),**Practical Organic Chemistry**, Pearson Education.

BSCH242A	Green Chemistry: Designing Chemistry for Human Health and Environment	L	T	P	C
		4	0	0	**4**

Course Objectives:

1. To understand the production and problems associated with waste generation, and explore the principles of Green Chemistry as a solution to prevent waste and promote sustainability.
2. To examine emerging green technologies and innovations, including green energy, solvents, and catalysts, and understand their role in accelerating sustainable development and addressing environmental challenges.
3. To analyze the application of Green Chemistry solutions in water pollution remediation, focusing on current technologies employed in water treatment to mitigate pollution and preserve water quality.
4. To explore the application of Green Chemistry principles in the pharmaceutical industry, including trends, case studies, and innovations, and recognize the impact of green initiatives through awards such as the US Presidential Green Challenge.

Course Learning Outcomes:

1. Students will develop a comprehensive understanding of waste production, its environmental impacts, and the principles of Green Chemistry as a means to prevent waste generation and promote sustainable practices.
2. Students will acquire knowledge of emerging green technologies, including green energy sources, solvents, and catalysts, and demonstrate the ability to evaluate their effectiveness in addressing environmental challenges such as climate change and pollution.
3. Students will gain insight into the application of Green Chemistry solutions in water pollution remediation, including catalytic degradation and photo-oxidation technologies, and develop skills in analyzing and implementing sustainable water treatment methods.
4. Students will analyze the integration of Green Chemistry principles in the pharmaceutical industry, including trends and case studies, and recognize the significance of academia and industry collaborations in driving innovation towards a greener circular economy and sustainable future.

Course Content

UNIT I

Waste: Production & Problems

Green Chemistry: The perfect toolbox to prevent wasteTwelve Principles of Green Chemistry

- UN sustainable development goals: How can Green Chemistry Contribute?
- Special Emphasis on Prevention of Waste

Waste: Production & Problems

Green Chemistry: The perfect toolbox to prevent waste

- Twelve Principles of Green Chemistry
- UN sustainable development goals: How can Green Chemistry Contribute?
- Special Emphasis on Prevention of Waste

UNIT II

Accelerating Innovations through Emerging Green Technologies

2.1 Green Energy

2.1.1 Global Warming (Climate Change)

2.1.2 Renewable energy

2.1.3 Microwave Assisted Synthesis

2.1.4 Ultrasound Assisted Synthesis

2.2 Green Solvents

2.2.1 Problems associated with traditional solvents

2.2.2 Water as a green solvent

2.2.3 Ionic Liquids

2.2.4 Bio-based Solvents

2.2.5 Supercritical CO_2

2.3 Green Catalysts

2.3.1 General Introduction to Catalysis

2.3.2 Types of Catalysts

2.3.3 Green Catalyst

***2.3.4** Nanocatalyst* **(Lectures:17)**

Green Chemistry solutions for water pollution *(Current Green Technologies employed in Water Treatment)*

3.1 Water Pollution and root causes
3.2 Catalytic Degradation of organic water pollutants
3.3 Photo-oxidation technologies
3.4 Removal of heavy metals (inorganic pollutants) via new adsorption technology

UNIT III

Green Chemistry in Pharmaceutical Industry

- Green Trends being followed in pharma
- Industrial Case Studies

Ranitidine , Celecoxib, Ibuprofen, Sertraline

- Special Recognition: US Presidential Green Challenge Awards

New Directions from Academia

- Innovations stemming from academia
- Academia Being Recognized: US Presidential Green Challenge Awards

UNIT IV

Green chemistry and resource efficiency: towards a green circular economy

- Resource efficiency, atom economy and the *E* factor
- Concept of Circular Economy: Renewable resources, the bio-based economy and waste valorisation
- Creating an Effective Regulatory System
- New Technological Developments: New Avenues for the Green Economy and Sustainable Future of Science and Technology

Future Prospectives

Reference books:

1. Anastas, P.T.; Warner, J.C.(1998), **Green Chemistry, Theory and Practice,** Oxford University Press.
2. Lancaster, M.(2016),**Green Chemistry An Introductory Text.**2nd Edition, RSC Publishing.
3. Cann , M. C.; Umile, T.P. (2008), **Real world cases in Green chemistry** Vol 11, American chemical Society,Washington.
4. Sharma, R.K.; Bandichhor, R. (2018),**Hazardous Reagent Substitution**, Royal Society of Chemistry.
5. Parent, K.; Kirchhoff,M. (2004),**Going Green: Integrating Green Chemistry into the Curriculum**, American Chemical Society.

BSCH268A	Green Chemistry: Designing Chemistry for Human Health and Environment Lab	L	T	P	C
		0	0	4	**2**

Course Objectives:

1. To understand the principles of Green Chemistry and apply them to design experiments with a focus on reducing environmental impact and promoting sustainability.
2. To learn and apply techniques for converting waste materials into valuable products through green chemistry methodologies, emphasizing the concepts of Reduce, Reuse, and Recycle.
3. To explore and implement green synthetic pathways using safe solvents and reaction conditions, aiming to minimize waste generation and maximize atom economy.
4. To gain practical experience in conducting experiments that contribute to environmental sustainability and promote the principles of Green Chemistry, such as conserving energy and greening waste.

Course Learning Outcomes:

1. Students will demonstrate an understanding of Green Chemistry principles and their application in experimental design, emphasizing the importance of safety, sustainability, and environmental impact reduction.
2. Students will acquire practical skills in converting waste materials into valuable products, demonstrating proficiency in applying green chemistry techniques such as biodiesel synthesis from waste cooking oil and making green plastics from renewable resources.
3. Students will be able to design and execute experiments for the green synthesis of nanoparticles and the degradation of toxic pollutants using catalytic processes, showcasing their ability to implement sustainable solutions to environmental challenges.
4. Students will develop competence in conducting green synthesis experiments, including microwave-assisted synthesis and the preparation of complex compounds using greener approaches, fostering a deeper understanding of sustainable chemistry practices and their real-world applications.

Course Content

Practical:

Green Chemistry experiments need to be designed with the help of the three magic R's- Reduce, Reuse and Recycle. While designing and practising green chemistry experiments, special emphasis should be made on utilizing the maximum tenets (principles) of Green Chemistry:

- **GETTING OFF TO A SAFE START:** Using Safer Starting Materials for Chemical Reactions
- **AIM AT DESIGNING GREEN SYNTHETIC PATHWAYS:** Involves safe solvents (for instance: liquid co_2, ionic liquids, water) and green reaction conditions.
- **AVOIDING WASTE:** Maximizing Atom Economy
- **CONSERVING ENERGY:** Using Lower Amounts of energy for chemical processes
- **GREENING WASTES:** Returning safe substances to the environment

Practical applications (Experiments to be performed):

(I) **Converting Waste to Wealth:**
- Synthesis of biodiesel from waste cooking oil

(II) **Using Renewable resources for deriving valuable products:**
- Making green plastics from corn starch

(III) **Greener approach to the synthesis of Gold/Silver Nanoparticles:**
- Green synthesis of gold/silver nanoparticles

(IV) **Degradation of toxic pollutants (dyes):**
- Catalytic degradation of dyes using nanoparticles (can be any)

(V) **Green Synthesis**
- Microwave assisted synthesis of copper phthalocyanine complex
- Preparation of Fe(III)AcAc Complex using a greener approach

Practical:

1. Sharma, R.K.; Sidhwani, I.T.; Chaudhuri, M.K. (2007),**Green Chemistry Experiments: A Monograph**, Tucker Prakashan.
2. Monograph on Green Chemistry Laboratory Experiments, Green Chemistry Task Force Committee, Department of Science and Technology, Government of India. http://dst.gov.in/green- chem.pdf.
3. Kirchhoff, M.; Ryan, M.A. (2002),**Greener Approaches to Undergraduate Chemistry Experiments**, American Chemical Society.
4. Ryan, M.A.; Tinnesand, M. (2002), **Introduction to Green Chemistry** (Ed), American Chemical Society, Washington DC.