Centurion University of Technology & Management
School of Applied Sciences

B. Sc. (Physics Hons.)
CBCS syllabus

(Three Years Programme)

2018

Semester Wise Course Structure

CHOICE BASED CREDIT SYSTEM IN B.Sc.(Honours)

Semester	Basket-1	Basket-2	Basket-3+4		Basket-5		
Sl. No.	CORE COURSE (14) Total 84 Credits	Ability Enhancement Compulsory Course (AECC) (2) Total 4 Credits	Domain** From Same/Related Discipline Minimum 26 Credits	Non-Domain [Skill Enhancement Course (SEC)-(2) Minimum 4 Credits + Discipline Specific Elective(DSE)- (4)] Minimum 24 credits	Non-Domain Generic Elective(GE) (4)	Domain** from Other Discipline Minimum 26 Credits	Semester wise Cumulative Credits
	C 1	(English / MIL Communication)/ Environmental Science	Domain Course of minimum 26 credits upto a maximum of 36 credits		GE – 1	Domain Course of minimum 26 credits upto a maximum of 36 credits	Minimum 20 Credits
	C2						
II	C 3	Environmental Science/(English/ MIL Communication)			GE – 2		Minimum 20 Credits
	C 4						
III	C 5			SEC – 1	GE – 3		Minimum 26 Credits
	C 6						
	C 7						
IV	C 8			SEC – 2	GE - 4		Minimum 26 Credits
	C 9						
	C 10						
V	C 11			DSE – 1			Minimum 24 Credits
	C 12			DSE – 2			
VI	C 13			DSE – 3			Minimum 24 Credits
	C 14			DSE (Project)– 4			
Total Credits							**Minimum 140**
* A student can opt more number of **Domain /GE courses** up to a maximum of 20 credits over the period of six semesters.							**Maximum 160**
**Each Domain must contain a Skill Component							

Basket-1

Core Courses (CC)

Sl. No.	Code	Subject Name	Type of course	T-P-Pr (Credit)	Credits
1	BSPH1101	Mathematical Physics-1	Theory + Practice	4-2-0	6
2	BSPH1102	Mechanics	Theory + Practice	4-2-0	6
3	BSPH1201	Thermal Physics	Theory	4-2-0	6
4	BSPH1202	Waves and optics	Theory + Practice	4-2-0	6
5	BSPH2301	Mathematical Physics II	Theory	4-2-0	6
6	BSPH2302	Electricity and Magnetism	Theory	4-2-0	6
7	BSPH2303	Analog systems and Applications	Theory + Practice	4-2-0	6
8	BSPH2401	Mathematical Physics III	Theory + Practice	4-2-0	6
9	BSPH2402	Elements of Modern Physics	Theory	4-2-0	6
10	BSPH2403	Digital systems and Applications	Theory + Practice	4-2-0	6
11	BSPH3501	Quantum Mechanics & Applications	Theory	4-2-0	6
12	BSPH3502	Solid State Physics	Theory	4-2-0	6
13	BSPH3601	Electro-magnetic Theory	Theory	4-2-0	6
14	BSPH3602	Statistical Mechanics	Theory	4-2-0	6

Basket-2

Ability Enhancement Compulsory Course (AECC)

Sl. No.	Code	Subject Name	Type of course	T-P-Pr (Credit)	Credits
1	BSFL1101 OR FCBS0101	English OR Environmental Science	Theory	2-0-0	2

Basket-3+4

Domain / Non Domain Courses

LIST OF DOMAINS

Sl. No.	Domain Name	Department offering
1	Renewable Energy	CREE
2	VLSI Design and Verification	ECE
3	AR VR Domain Using Unity Game Engine	CSE
4	Machine Learning	CSE
5	Embedded Systems	CSE
6	Radio Imaging Technique	PARAMEDIC

Note: Students can take any other relevant Domain offered by any department of CUTM.

Non Domain Courses (DSE Courses)

Sl. No.	Code	Subject Name	Type of course	T-P-Pr (Credit)	Credits
1	BSPH3503	Experimental Techniques	Theory + Practice	4-2-0	6
2	BSPH3504	Embedded systems- Introduction to Microcontroller	Theory + Practice	4-2-0	6
3	BSPH3505	Physics of Devices and Communication	Theory + Practice	4-2-0	
4	BSPH3506	Advanced Mathematical Physics-I	Theory + Practice	4-2-0	6
5	BSPH3507	Advanced Mathematical Physics-II	Theory	6-0-0	6
6	BSPH3508	Classical Dynamics	Theory	6-0-0	6
7	BSPH3603	Applied Dynamics	Theory + Practice	4-2-0	6
8	BSPH3604	Communication System	Theory + Practice	4-2-0	6
9	BSPH3605	Nuclear and Particle Physics	Theory	6-0-0	6
10	BSPH3606	Astronomy and Astrophysics	Theory	6-0-0	6
11	DEET0300	Project	Project	0-0-6	6

Skill Enhancement Courses

Sl. No.	Code	Subject Name	Type of course	T-P-Pr (Credit)	Credits
1	BSPH2001	Physics Workshop Skills	Practice	0-0-2	2
2	BSPH2002	Computational Physics Skills	Practice	0-0-2	2
3	BSPH2003	Electrical circuits and Network Skills	Practice	0-0-2	2
4	BSPH2004	Basic Instrumentation Skills	Practice	0-0-2	2
5	BSPH2005	Applied Optics	Practice	0-0-2	2

Note: Any two (for Non-Domain)/any-one or as deemed fit (for Domain) Skill Enhancement Courses to be chosen from the above list.

Basket-5

Generic Elective (GE)

(Subjects from other Disciplines)

Basket-1

Core Courses (CC)

BSPH1101 Mathematical Physics-I

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
Mathematical Physics-1	**BSPH1101**	**Theory + Practice**	**4-2-0**	**Nil**

Objective

- To introduce the students to understand the physical meaning of different mathematical methods
- The emphasis of course is on applications in solving problems of interest to physicists.
- Highlights the use of computational methods to solve physical problems

Learning Outcome

Upon successful completion of this course, students will be :

- Able to understand the mathematical and physical interpretation of vector calculus.
- Able to handle different coordinate systems
- Introduced to the concept of probability

Evaluation Systems

	Component	***% of Marks***	***Method of Assessment***
Internal Examination	Midterm Test	*20*	Written examination
	Experiments	*30*	Lab work, report, viva
External Examination	Semester Examination	*30*	Written examination
	Experiments	*20*	Lab work, report, viva
Total		*100*	

Course Outline

Module-I

Calculus:

Approximation: Taylor and binomial series (statements only).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.

Module-II

Vector Calculus:

Recapitulation of vectors: Properties of vectors under rotations. Scalar product and itsinvariance under rotations. Vector product, Scalar triple product and their interpretation in terms of area and volume respectively. Scalar and Vector fields.

Module-III

Vector Differentiation: Directional derivatives and normal derivative. Gradient of ascalar field and its geometrical interpretation. Divergence and curl of a vector field. Del and Laplacian operators. Vector identities.

Module-IV

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).

Module-V

Orthogonal Curvilinear Coordinates:

Orthogonal Curvilinear Coordinates. Derivation of Gradient, Divergence, Curl andLaplacian in Cartesian, Spherical and Cylindrical Coordinate Systems.

Module-VI

Introduction to probability:

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

Module-VII

Dirac Delta function and its properties:

Definition of Dirac delta function. Representation as limit of a Gaussian function andrectangular function. Properties of Dirac delta function.

Text Books:

1. Mathematical Physics by Satyaprakash, S.Chand&Co.
2. Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris, 2013, 7th Edn., Elsevier.

Reference Books:

1. An introduction to ordinary differential equations, E.A. Coddington, 2009, PHI learning
2. Differential Equations, George F. Simmons, 2007, McGraw Hill.
3. Mathematical Tools for Physics, James Nearing, 2010, Dover Publications.
4. Mathematical methods for Scientists and Engineers, D.A. McQuarrie, 2003, Viva Book
5. Advanced Engineering Mathematics, D.G. Zill and W.S. Wright, 5 Ed., 2012, Jones and Bartlett Learning
6. Mathematical Physics, Goswami, 1st edition, Cengage Learning
7. Engineering Mathematics, S.Pal and S.C. Bhunia, 2015, Oxford University Press
8. Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.
9. Essential Mathematical Methods, K.F.Riley&M.P.Hobson, 2011, Cambridge Univ. Press

Mathematical Physics I Lab

10 Labs

Topics	**Description with Applications**
Introduction and Overview	Computer architecture and organization, memory andInput/output devices
Basics of scientific computing	Binary and decimal arithmetic, Floating point numbers, algorithms, Sequence, Selection and Repetition, single and double precision arithmetic, underflow &overflowemphasizethe importance of making equations in termsof 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 andlooping statements) (*If-statement. If-else Statement. Nested if Structure. Else-if Statement. Ternary Operator. Goto Statement. Switch Statement. Unconditional andConditional 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

Topics	Description with Applications
Random number generation	Area of circle, area of square, volume of sphere, value of pi (**π**)
Solution of Algebraic andTranscendentalequations by Bisection, Newton Raphsonand Secant methods	Solution of linear and quadratic equation, solving $\alpha = tan\alpha$; $I = I_0 \left(\frac{sin\alpha}{\alpha}\right)^2$ in optics
Interpolation by Newton Gregory Forwardand Backward difference formula, Errorestimation of linear interpolation	Evaluation of trigonometric functions e.g. *sin θ, cosθ,tan θ, etc.*

Referred Books:

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

BSPH1102 Mechanics

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
Mechanics	**BSPH1102**	**Theory + Practice**	**4-2-0**	**Nil**

Objective

- To describe static equilibrium of particles and rigid bodies in two and three dimensions.
- To analyse the properties of surfaces & solids in relation to moment of inertia.
- To illustrate the laws of motion, kinematics of motion and their interrelationship.
- To analyse the hydrostatic and viscous properties of liquid.

Learning Outcome

Upon successful completion of this course, students will be able to:

- Understand Parameters defining the motion of mechanical systems and their degrees of freedom.
- Understand and work with solids in mechanical systems. centre of mass and inertia tensor of mechanical systems.
- Study Newton's laws of motion and conservation principles.
- Introduction to analytical mechanics as a systematic tool for problem solving.

Evaluation Systems

	Component	***% of Marks***	***Method of Assessment***
Internal Examination	Midterm Test	*20*	Written examination
	Experiments	*30*	Lab work, report, viva
External Examination	Semester Examination	*30*	Written examination
	Experiments	*20*	Lab work, report, viva
Total		*100*	

Course Outline

Module-I

Overview of single particle dynamics: Reference frames. Inertial frames; Review of Newton's Laws of Motion. Galilean transformations; Galilean invariance. Dynamics of a system of particles. Centre of Mass. Principle of conservation of momentum. Impulse.

Module-II

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

Module-III

Collisions: Elastic and inelastic collisions between particles. Centre of Mass

Elasticity: Relation between Elastic constants. Twisting torque on a Cylinder or Wire

Module-IV

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.

Module-V

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

Module-VI

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.

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.

Module-VII

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.

Text Books:

1. Mechanics, D.S. Mathur, S. Chand and Company Limited, 2000

Reference Books:

2. An introduction to mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw-Hill.
3. Mechanics, Berkeley Physics, vol.1, C.Kittel, W.Knight, et.al. 2007, Tata McGraw-Hill.
4. Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley.
5. Analytical Mechanics, G.R. Fowles and G.L. Cassiday. 2005, Cengage Learning.

Mechanics Lab

(Any 8 to be done)

1. To determine the value of g using Bar Pendulum.
2. To determine the Young's Modulus of a Wire by Searle's method.
3. To determine the Modulus of Rigidity of a Wire by static torsion method.
4. To determine the Moment of Inertia of a Flywheel.
5. To determine Coefficient of Viscosity of water by Capillary Flow *Method (Poiseuille's method).*
6. Measurements of length (or diameter) using vernier caliper, screw gauge and travelling microscope.
7. To determine the height of a building using a Sextant.

8. To study the Motion of Spring and calculate (a)Spring constant, (b) **g** and (c) Modulus of rigidity.
9. To determine **g** and velocity for a freely falling body using Digital Timing Technique.
10. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.

Reference Books

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

BSPH1201 Thermal Physics

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
Thermal Physics	**BSPH1201**	**Theory + Practice**	**4-2-0**	**Nil**

Objective

- To acquire working knowledge of the zero-th, first and second law of thermodynamics.
- To apply the laws of thermodynamics.
- To link thermodynamics to the micro description used in classical Statistical Mechanics.

Learning Outcome

Learning Outcome

Upon successful completion of this course,

1. Student identifies the relationship and correct usage of work, energy, heat capacity, specific heat, latent heat, and enthalpy.
2. Student can compute entropy for simple systems such as the ideal gas (Sakur-Tetrode equation), the Einstein solid, and the two-level paramagnet.
3. Student can compute the value of selected thermodynamical variables at thermal, mechanical, and/or diffusive equilibrium.
4. Student can compute the efficiency of idealized engines such as the Carnot cycle, the Otto cycle, and the Diessel cycle.

Evaluation Systems

	Component	***% of Marks***	***Method of Assessment***
Internal Examination	Midterm Test	*20*	Written examination
	Experiments	*30*	Lab work, report, viva
External Examination	Semester Examination	*30*	Written examination
	Experiments	*20*	Lab work, report, viva
Total		*100*	

Course Outline

Module-I

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, Work and Internal Energy in different processes. Applications of first law.

Module-II

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. Carnot's Theorem. Refrigerator & coefficient of performance, 2nd Law of Thermodynamics: Kelvin-Planck and Clausius Statements and their Equivalence. Applications of Second Law of thermodynamics. Absolute scale of temperature.

Module-III

Entropy: Concept of Entropy, 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. Temperature–Entropy diagrams for Carnot's Cycle.
Third Law of Thermodynamics. Unattainability of Absolute Zero.

Module-IV

Thermodynamic Potentials: Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, And Gibb's Free Energy. Their Definitions, Properties and Applications. Cooling due to adiabatic demagnetization, ClausiusClapeyron Equation.
Maxwell's Thermodynamic Relations and applications

Module-V

Kinetic Theory of Gases

Distribution of Velocities: Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas. Mean, RMS and Most Probable Speeds. Degrees of Freedom. Law of Equipartition of Energy (No proof required). Specific heats of Gases.

Module-VI

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.

Module-VII

Real Gases: Behaviour of Real Gases. Van der Waal's Equation of State for Real Gases. Values of Critical Constants. 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.

Text Books:

1. Heat and Thermodynamics, M.W. Zemansky, Richard Dittman, 1981, McGraw-Hill.

Reference Books:

2. A Treatise on Heat, MeghnadSaha, and B.N.Srivastava, 1958, Indian Press
3. Thermal Physics, S. Garg, R. Bansal and Ghosh, 2nd Edition, 1993, Tata McGraw-Hill
4. Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer.
5. Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Sears & Salinger 1988, Narosa.
6. Concepts in Thermal Physics, S.J. Blundell and K.M. Blundell, 2nd Ed., 2012, Oxford University Press.
7. Thermal Physics, A. Kumar and S.P. Taneja, 2014, R. Chand Publications.

Thermal Physics Lab

(Atleast 6 to be done from the following list)

1. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee's method.
2. To determine Mechanical Equivalent of Heat, J, by Joule's calorimeter.
3. To study the variation of Thermo-Emf of a Thermocouple with Difference of temperature of its Two Junctions.
4. To determination of radiation correction of ice by joule's calorimeter.
5. To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.
6. To determine the Coefficient of Thermal Conductivity of Cu by Searle's Apparatus.
7. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method.
8. To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT).
9. 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

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

BSPH1202 Waves and Optics

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
Waves and Optics	**BSPH1202**	**Theory + Practice**	**4-2-0**	**Nil**

Objective

1. To aware the students about various phenomenon of waves and optics.
2. To solve many types of problems involving wave motion.
3. The understand the phenomenon like Interference, Diffraction through practice mode..

Learning Outcome

Upon successful completion of this course, students will be able to:

1. Understand the physics behind various phenomena in wave and optics.
2. Understand various natural phenomena (like interference and diffraction) which are happening in their surroundings.
3. Understand longitudinal, transverse waves and their applications.

Evaluation Systems

	Component	***% of Marks***	***Method of Assessment***
Internal Examination	Midterm Test	*20*	Written examination
	Experiments	*30*	Lab work, report, viva
External Examination	Semester Examination	*30*	Written examination
	Experiments	*20*	Lab work, report, viva
Total		*100*	

Course Outline

Module-I

Superposition of Collinear Harmonic oscillations: Linearity and Superposition Principle. Superposition of two collinear oscillations having (1) equal frequencies and (2) different frequencies (Beats).

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.

Module-II

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.

Module-III

Superposition of Two Harmonic Waves: Standing (Stationary) Waves in a String: Fixed and Free Ends. Analytical Treatment.Phase and Group Velocities.Changes withrespect to Position and Time.Energy of Vibrating String.Transfer of Energy.NormalModes 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.

Module-IV

Wave Optics

Interference.Huygens Principle.Division of amplitude and wave front. 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.

Module-V

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

Module-VI

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

Module-VII

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.

Text Books

1.Optics, AjoyGhatak, 2008, Tata McGraw Hill

Reference Books

1. Waves: Berkeley Physics Course, vol. 3, Francis Crawford, 2007, Tata McGraw-Hill.
2. Fundamentals of Optics, F.A. Jenkins and H.E. White, 1981, McGraw-Hill
3. Principles of Optics, Max Born and Emil Wolf, 7th Edn., 1999, Pergamon Press.
4. The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons.
5. The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill.
6. Fundamental of Optics, A. Kumar, H.R. Gulati and D.R. Khanna, 2011, R. ChandPublications.

Waves and Optics Lab

(Any 6 to be done)

1. To determine wavelength of sodium light using Newton's Rings.
2. To determine wavelength of Na source using plane diffraction grating.

3. To investigate the motion of coupled oscillators.
4. To study Lissajous Figures.
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 dispersive power and resolving power of a plane diffraction grating.

Reference Books

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

BSPH2301 Mathematical Physics-II

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
Mathematical Physics-II	**BSPH2301**	**Theory + Practice**	**4-2-0**	**Nil**

Objective

- Fourier series and its application to the solution of partial differential equations.
- Study of Second Order Linear Differential Equations and their importance
- Introduce the concepts of Laplace equation, its application, basic statistical data analysis and curve fitting.

Learning Outcome

Upon successful completion of this course, students will be able to:

- Expand a function in Fourier series.
- Find the solution of the wave, diffusion and Laplace equations using the Fourier series.
- Find the mean and the variance of a random variable.
- describe special functions and their recurrence relations

Evaluation Systems

	Component	***% of Marks***	***Method of Assessment***
Internal Examination	Midterm Test	*20*	Written examination
	Experiments	*30*	Lab work, report, viva
External Examination	Semester Examination	*30*	Written examination
	Experiments	*20*	Lab work, report, viva
Total		*100*	

Course Outline

Module-I

Fourier series: Periodic functions. Orthogonality of sine and cosine functions, DirichletConditions (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.

Module-II

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.

Module-III

Frobenius Method and Special Functions: Singular Points of Second Order LinearDifferential Equations and their importance. Frobenius method and its applications to differential equations. Legendre, Bessel, Hermite and Laguerre Differential Equations.

Module-IV

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.

Module-V

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

Module-VI

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

Module-VII

Partial Differential Equations: Solutions to partial differential equations, usingseparation 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.

Text Book:

1. Mathematical Methods for Physicists: Arfken, Weber, 2005, Harris, Elsevier.

Reference Books:

1. Mathematical Physics by B.S.Rajput, APragati Edition.
2. Mathematical Physics by Satyaprakash, S.Chand&Co.
3. Introduction to Mathematical Physics by Charlie Harper.
4. Mathematical Physics by H.K.Dass and Dr. Rama Verma, S.Chand Publication.
5. Mathematical Physics by B.D.Gupta.
6. Fourier analysis by M.R. Spiegel, 2004, Tata McGraw-Hill.
7. Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole.
8. Differential Equations, George F. Simmons, 2006, Tata McGraw-Hill.
9. Partial Differential Equations for Scientists & Engineers, S.J. Farlow, 1993, Dover Pub.
10. Engineering Mathematics, S.Pal and S.C. Bhunia, 2015, Oxford University Press
11. Mathematical methods for Scientists & Engineers, D.A. McQuarrie, 2003, Viva Books

Mathematical Physics-II Lab

Topics	Description with Applications
Introduction to Numerical computations of software Scilab	Introduction to Scilab, Advantages and disadvantages,Scilab environment, Command window, Figurewindow, Edit window, Variables and arrays, Initialisingvariables in Scilab, Multidimensional arrays, Subarray,Special values, Displaying output data, data file, Scalarand array operations,

	Hierarchy of operations, Built inScilab functions, Introduction to plotting, 2D and 3Dplotting (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) Userdefined functions, Introduction to Scilab functions,Variable passing in Scilab, optional arguments,preserving data between calls to a function, Complexand Character data, string function, Multidimensionalarrays (2) an introduction to Scilab file processing, fileopening and closing, Binary I/o functions, comparingbinary and formatted functions, Numerical methods anddeveloping the skills of writing a program (2).
Curve fitting, Least square fit, Goodnessof fit, standard deviation	Ohms law to calculate R, Hooke's law to calculate springconstant
Solution of Linear system of equationsby Gauss elimination method and GaussSeidal method. Diagonalization ofmatrices, Inverse of a matrix, Eigenvectors, eigen values problems	Solution of mesh equations of electric circuits (3 meshes) Solution of coupled spring mass systems (3 masses)
Generation of Special functions 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-Kuttasecondorder 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 andSteady state solution • Apply above to LCR circuits also Solve $x^2\frac{d^2y}{dx^2} - 4x(1+x)\frac{dy}{dx} + 2(1+x)y = x^3$ With the boundary conditions at $x = 1, y = \frac{1}{2}e^2, \frac{dy}{dx} = -\frac{3}{2}e^2 - 0.5$ In the range $1 \leq x \leq 3$. Plot y and dy/dx 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

Text Books:

1. Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3rd ed., 2006, Cambridge University Press

Reference Books:

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

BSPH2302 Electricity and Magnetism

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
Electricity and Magnetism	**BSPH2302**	**Theory + Practice**	**4-2-0**	**Nil**

Objective

- Study the electric and magnetic fields in details
- Study and explore the dielectric properties of matter
- Study the relation between electric and magnetic fields
- Understand theorems through experiments
- Understand the LCR circuit through practice mode

Learning Outcome

Upon successful completion of this course, students will be able to:

- Understand the characteristics and properties of electric and magnetic fields.
- Understand the behavior and use of dielectrics.
- Understand the Maxwell equation and their usefulness.
- Experiences electricity & magnetism in practice mode.

Evaluation Systems

	Component	***% of Marks***	***Method of Assessment***
Internal Examination	Midterm Test	*20*	Written examination
	Experiments	*30*	Lab work, report, viva
External Examination	Semester Examination	*30*	Written examination
	Experiments	*20*	Lab work, report, viva
Total		*100*	

Course Outline

Module-I

Electric Field

Electric field: Electric field lines. Electric flux. Gauss' Law with applications to charge distributions with spherical, cylindrical and planar symmetry.

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.

Module-II

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.

Module-III

Dielectric Properties of Matter: Electric Field in matter. Polarization, PolarizationCharges. 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.

Module-IV

Magnetic Field: Magnetic force between current elements and definition of MagneticField**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.

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.

Module-V

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

Module-VI

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

Module-VII

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

Text Books:

1. Electricity and Magnetism by D.C.Tayal, Himalaya Publishing House.

Reference Books:

1. Electricity and Magnetism - K. K. Tiwari
2. Elements of Electromagnetics, M.N.O. Sadiku, 2010, Oxford University Press.
3. Engineering Electromagnetics by W.H.Hayt&J.A.Buck.
4. Introduction to Electrodynamics by D J Griffiths, PHI Learning, 2009.
5. Electricity and Magnetism - Segal, Chopra, Segal.
6. Electricity, Magnetism & Electromagnetic Theory, S. Mahajan and Choudhury, 2012, Tata McGraw
7. Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-Hill Education

Electricity and Magnetism Lab

Atleast 8 of the following experiments to be done.

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.

Text Books

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House

Reference Books:

1. A Text Book of Practical Physics, I.Prakash& Ramakrishna, 11th Ed., 2011, KitabMahal
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
3. Engineering Practical Physics, S.Panigrahi and B.Mallick, 2015, Cengage Learning.
4. A Laboratory Manual of Physics for undergraduate classes, D.P.Khandelwal, 1985, Vani Pub

BSPH2303 Analog Systems and Applications

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
Analog Systems and Applications	**BSPH2303**	**Theory + Practice**	**4-2-0**	**Nil**

Objective

- The objectives of this subject are to Learn Fundamentals of electronic devices.
- Design and Applications of electronic circuits.
- Learn through practice mode the fundamental electronic devices.

Learning Outcome

Upon successful completion of this course, students will be able to:

- Understand Semiconductor diodes, bipolar junction transistor
- Describe the application of transistors for Current and voltage amplification.
- Sketch, explain and design the amplifier circuit for given specification and analyze them discuss oscillator principles, and frequency stability. Analyze the different types of Oscillators.

Evaluation Systems

	Component	***% of Marks***	***Method of Assessment***
Internal Examination	Midterm Test	*20*	Written examination
	Experiments	*30*	Lab work, report, viva
External Examination	Semester Examination	*30*	Written examination
	Experiments	*20*	Lab work, report, viva
Total		*100*	

Course Outline

Module-I

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. CurrentFlow Mechanism in Forward and Reverse Biased Diode. Drift Velocity. Derivation for Barrier Potential, Barrier Width and Current for Step Junction. Current Flow Mechanism in Forward and Reverse Biased Diode.

Module II

Two-terminal Devices and their Applications: (1) Rectifier Diode: Half-waveRectifiers. 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.

Module-III

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, Cut-off and Saturation Regions.

Module-IV

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.

Module-V

Coupled Amplifier: Two stage RC-coupled amplifier and itsfrequency response

Feedbackin Amplifiers: Effects of Positive and Negative, Feedback on Input, Impedance, Output Impedance, Gain, Stability, Distortion and Noise.

Module-VI

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.

Module-VII

Applications of Op-Amps: (1) Inverting and non-inverting amplifiers, (2) Adder, (3)Subtractor, (4) Differentiator, (5) Integrator, (6) Log amplifier, (7) Zero crossing detector (8) Wein bridge oscillator.

Text Books:

1. Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.

Reference Books:

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

Analog Systems and Applications Lab

Atleast 8 of the following experiments to be done

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 an inverting amplifier using Op-amp (741,351) for dc voltage of given gain
10. To design inverting amplifier using Op-amp (741,351) and study its frequency response
11. To design non-inverting amplifier using Op-amp (741,351) & study its frequency response
12. To study the zero-crossing detector and comparator
13. To add two dc voltages using Op-amp in inverting and non-inverting mode
14. To design a precision Differential amplifier of given I/O specification using Op-amp.
15. To investigate the use of an op-amp as an Integrator.
16. To investigate the use of an op-amp as a Differentiator.
17. To design a circuit to simulate the solution of a $1^{st}/2^{nd}$ order differential equation.

Text Books:

1. Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw Hill.

Reference Books:

1. OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4^{th} edition, 2000, Prentice Hall.
2. Electronic Principle, Albert Malvino, 2008, Tata Mc-Graw Hill.
3. Electronic Devices & circuit Theory, R.L. Boylestad& L.D. Nashelsky, 2009, Pearson

BSPH2401 Mathematical Physics-III

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
Mathematical Physics III	**BSPH2401**	**Theory + Practice**	**4-2-0**	**Nil**

Objective

- Perform algebra with complex numbers.
- Understanding complex-differentiable functions, performing their differentiation and integration.
- Expanding functions in Laurent and Taylor's series.
- Compute complex line integrals.
- Use the residue theorem to evaluate integrals.
- Study of Integrals Transforms like Fourier and Laplace transforms.

Learning Outcome

Upon successful completion of this course, students will be able to:

- Perform algebra of complex numbers.
- Express complex-differentiable functions as power series.
- Use Euler's method to derive approximations of solutions to initial value problems for firstorder ODEs.
- Calculate the Laplace Transform of basic functions using the definition.
- Identify the isolated singularities of a function and determine whether they are removable, poles, or essential.
- Use the residue theorem to compute complex line integrals and real integrals.
- Use Scilab to solve mathematical problems.

Evaluation Systems

	Component	***% of Marks***	***Method of Assessment***
Internal Examination	Midterm Test	*20*	Written examination
	Experiments	*30*	Lab work, report, viva
External Examination	Semester Examination	*30*	Written examination
	Experiments	*20*	Lab work, report, viva
Total		*100*	

Course Outline

.**Module-I**

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.

Module-II

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.

Module-III

Simply and multiply connected region. Laurent and Taylor's expansion. Residues and Residue Theorem. Application in solving Definite Integrals.

Module-IV

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.).

Module-V

Three dimensional Fourier transforms with examples. Application of Fourier Transforms to differential equations: One dimensional Wave and Diffusion/Heat Flow Equations.

Module-VI

Laplace Transforms: Laplace Transform (LT) of Elementary functions. Properties of LTs: Change of Scale Theorem, Shifting Theorem. LTs of 1^{st} and 2^{nd} order Derivatives and Integrals of Functions, Derivatives and Integrals of LTs. LT of Unit Step function,

Module-VII

Dirac Delta function, Periodic Functions. Convolution Theorem. Inverse LT. Application of Laplace Transforms to 2^{nd} order Differential Equations: Damped Harmonic Oscillator, Simple Electrical Circuits, Solution of heat flow along infinite bar using Laplace transform.

Text Books:

1. Mathematical Methods for Physicists: Arfken, Weber, 2005, Harris, Elsevier

Reference Books:

1. Mathematical Physics by B.S.Rajput, APragati Edition.
2. Mathematical Physics by Satyaprakash, S.Chand&Co.
3. Introduction to Mathematical Physics by Charlie Harper.
4. Mathematical Physics by H.K.Dass and Dr. Rama Verma, S.Chand Publication.
5. Mathematical Physics by B.D.Gupta.
6. Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3^{rd} ed., 2006, Cambridge University Press
7. Mathematics for Physicists, P. Dennery and A.Krzywicki, 1967, Dover Publications
8. Complex Variables, A.S.Fokas&M.J.Ablowitz, 8^{th} Ed., 2011, Cambridge Univ. Press
9. Complex Variables, A.K. Kapoor, 2014, Cambridge Univ. Press
10. Complex Variables and Applications, J.W. Brown & R.V. Churchill, 7^{th} Ed. 2003, Tata McGraw-Hill
11. First course in complex analysis with applications, D.G. Zill and P.D. Shanahan, 1940, Jones &

Bartlett

Mathematical Physics III Lab

Atleast 8 of the following experiments to be done.

Scilab/C++ based simulations experiments based on Mathematical Physics problemslike

1. Solve differential equations:
   $dy/dx = e^{-x}$ with y = 0 for x = 0
   $dy/dx + e\text{-}xy = x^2$
   $d^2y/dt^2 + 2\ dy/dt = -y$
   $d^2y/dt^2 + e^{-t}dy/dt = -y$
2. Dirac Delta function:
   Evaluate $\frac{1}{\sqrt{2\pi\sigma^2}}\int e^{-(x-2)^2/2\sigma^2}\,(x+3)dx$ for $\sigma = 1, 0.1, 0.01$ and show it tends to 5.
3. Fourier series:
   Program to sum $\sum_{n=1}^{\infty}(0.2)^n$
   Evaluate the fourier co efficients of a given periodic function.
4. Frobenius method and special function:
   $$\int_{-1}^{+1} P_n(\mu)P_m(\mu)d\mu = \delta_{m,n}$$
   Plot $P_n(x)$, $j_v(x)$
   Show recursion relation.
5. Calculation of error for each data point of observations recorded in experiments done in previous semesters (choose any two).
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 Npoints find its value at an intermediate point. Complex analysis: Integrate$1/(x^2+2)$ numerically and check with computer integration.
8. Compute the n^{th} roots of unity for n = 2, 3, and 4.
9. Find the two square roots of $-5+12j$.
10. Integral transform: FFT of e^{-x^2}
11. Solve Kirchoff's Current law for any node of an arbitrary circuit using Laplace'stransform.
12. Solve Kirchoff's Voltage law for any loop of an arbitrary circuit using Laplace'stransform.
13. Perform circuit analysis of a general LCR circuit using Laplace's transform.

Text Books:

- Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3rd ed., 2006, Cambridge University Press

Reference Books:

1. Mathematics for Physicists, P. Dennery and A. Krzywicki, 1967, Dover Publications
2. Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A. VandeWouwer, P. Saucez, C. V. Fernández. 2014 Springer ISBN: 978-3319067896
3. A Guide to MATLAB, B.R. Hunt, R.L. Lipsman, J.M. Rosenberg, 2014, 3rdEdn., Cambridge University Press
4. Scilab by example: M. Affouf, 2012. ISBN: 978-1479203444
5. Scilab (A free software to Matlab): H.Ramchandran, A.S.Nair. 2011 S.Chand& Company
6. Scilab Image Processing: Lambert M. Surhone. 2010 Betascript Publishing
7. https://web.stanford.edu/~boyd/ee102/laplace_ckts.pdf
8. ocw.nthu.edu.tw/ocw/upload/12/244/12handout.pdf

SPH2402 Elements of Modern Physics

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
Elements of Modern Physics	**BSPH2402**	**Theory + Practice**	**4-2-0**	**Nil**

Objective

- To provide students conceptual frameworks of modern physics like Quantum Mechanics, atomic Physics and Nuclear Physics.
- From the beginning of Quantum mechanics to Schrodinger equation and its applications.
- To introduce students to the fundamentals of atomic physics and nuclear physics.
- To introduce them to the basic Laser principles and Properties.

Learning Outcome

Upon successful completion of this course, students will be able to:

1. Understand and explain the differences between classical and quantum mechanics.
2. Solve Schrodinger equation for simple potentials.
3. Assess whether a solution to a given problem is physically reasonable.
4. Identify properties of the nucleus and other sub-atomic particles.
5. Describe theories explaining the structure of atoms and the origin of the observed spectra.
6. Explain different Laser used and make a comparison between them

Evaluation Systems

	Component	***% of Marks***	***Method of Assessment***
Internal Examination	Midterm Test	*20*	Written examination
	Experiments	*30*	Lab work, report, viva
External Examination	Semester Examination	*30*	Written examination
	Experiments	*20*	Lab work, report, viva
Total		*100*	

Course Outline

Module-I

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.

Module-II

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.

Module-III

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.

Module-IV

One dimensional infinitely rigid box- energy eigenvalues and Eigen functions, normalization; Quantum dot as example; Quantum mechanical scattering and tunnelling in one dimension-across a step potential & rectangular potential barrier.

Module-V

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.

Module- VI

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.
Fission and fusion- mass deficit, relativity and generation of energy; Fission - nature of fragments and emission of neutrons.

Module-VII

Lasers: Einstein's A and B coefficients. Metastable states. Spontaneous and Stimulatedemissions. Optical Pumping and Population Inversion. Three-Level and Four-Level Lasers. Ruby Laser and He-Ne Laser. Basic lasing.

Text Books:

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

Reference Books:

1. Introduction to Modern Physics, Rich Meyer, Kennard, Coop, 2002, Tata McGraw Hill
2. Introduction to Quantum Mechanics, David J. Griffith, 2005, Pearson Education. Physics for scientists and Engineers with Modern Physics, Jewett and Serway, 2010, Cengage Learning.
3. Modern Physics, G.Kaur and G.R. Pickrell, 2014, McGraw Hill
4. Quantum Mechanics: Theory & Applications, A.K.Ghatak&S.Lokanathan, 2004, Macmillan
5. Modern Physics, J.R. Taylor, C.D. Zafiratos, M.A. Dubson, 2004, PHI Learning.
6. Theory and Problems of Modern Physics, Schaum`s outline, R. Gautreau and W. Savin, 2nd Edn, Tata McGraw-Hill Publishing Co. Ltd.
7. Quantum Physics, Berkeley Physics, Vol.4. E.H.Wichman, 1971, Tata McGraw-Hill Co.
8. Basic ideas and concepts in Nuclear Physics, K.Heyde, 3rd Edn., Institute of Physics Pub.
9. Six Ideas that Shaped Physics: Particle Behave like Waves, T.A.Moore, 2003, McGraw Hill

Elements of Modern Physics Lab

At least any 8 of the following experiments to be done.

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 tunnelling 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

Text Books

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House

Reference Books:

1. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
2. A Text Book of Practical Physics, I.Prakash& Ramakrishna, 11thEdn, 2011,Kitab Mahal

BSPH2403 Digital Systems and Applications

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
Digital Systems and Applications	**BSPH2403**	**Theory + Practice**	**4-2-0**	**Nil**

Objective

- To make the student understand the digital system.
- To understand the Boolean algebra and data processing circuit.
- Knowing the computer architecture.
- Understanding the arithmetic and sequential circuit and microprocessors.

Learning Outcome

Upon successful completion of this course, students will be able to:

- Gain both theoretical and experimental knowledge about digital electronics.
- Understand the computer architecture.
- Verify and design various logic gates.
- Write programs using 8085 microprocessor.

Evaluation Systems

	Component	***% of Marks***	***Method of Assessment***
Internal Examination	Midterm Test	*20*	Written examination
	Experiments	*30*	Lab work, report, viva
External Examination	Semester Examination	*30*	Written examination
	Experiments	*20*	Lab work, report, viva
Total		*100*	

Course Outline

Module-I

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

Module-II

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 of ICs. Examples of Linear and Digital lCs.

Module-III

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.

Module-IV

Boolean algebra: De Morgan's Theorems. Boolean Laws. Simplification of LogicCircuit 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.

Data processing circuits: Basic idea of Multiplexers, De-multiplexers, Decoders,Encoders.

Module-V

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

Sequential Circuits: SR, D, and JK Flip-Flops. Clocked (Level and Edge Triggered)Flip-Flops. Preset and Clear operations. Race-around conditions in JK Flip-Flop. M/S JK Flip-Flop.

Module-VI

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

Module-VII

Intel 8085 Microprocessor Architecture: Main features of 8085. Block diagram.Components. Pin-out diagram. Buses. Registers. ALU.

Introduction to Assembly Language: 1 byte, 2 byte & 3 byte instructions.

Text Books:

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

Reference Books:

1. Fundamentals of Digital Circuits, Anand Kumar, 2ndEdn, 2009, PHI Learning Pvt. Ltd.
2. Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
3. Digital Electronics G K Kharate ,2010, Oxford University Press
4. Digital Systems: Principles & Applications, R.J.Tocci, N.S.Widmer, 2001, PHI Learning
5. Logic circuit design, Shimon P. Vingron, 2012, Springer.
6. Digital Electronics, SubrataGhoshal, 2012, Cengage Learning.
7. Digital Electronics, S.K. Mandal, 2010, 1st edition, McGraw Hill
8. Microprocessor Architecture Programming & applications with 8085, 2002, R.S. Goankar, Prentice Hall.

Digital Systems Lab

Atleast 8 of the followings to be done.

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

13. To make a 4-bit Shift Register (serial and parallel) using D-type/JK Flip-Flop ICs.
14. To design an astablemultivibrator of given specifications using 555 Timer.
15. To design a monostablemultivibrator of given specifications using 555 Timer.
16. 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.).

Text Books:

1. Modern Digital Electronics, R.P. Jain, 4th Edition, 2010, Tata McGraw Hill.

Reference Books:

1. Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw Hill.
2. Microprocessor Architecture Programming and applications with 8085, R.S. Goankar, 2002, Prentice Hall.
3. Microprocessor 8085:Architecture, Programming and interfacing, A. Wadhwa, 2010, PHI Learning.

BSPH3501 Quantum Mechanics and Applications

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
Digital Systems and Applications	**BSPH2403**	**Theory + Practice**	**4-2-0**	**Nil**

Objective

- Understanding of comparison of classical and quantum mechanics.
- To acquire working knowledge of the Quantum Mechanics postulate on the physical systems.
- Understanding of quantized quantities in nature.

Learning Outcome

Upon successful completion of this course, students will be able to:

- Compute the probability of finding the system in a given state..
- Solve the time-independent Schrodinger equation as an intermediate step to solve the time-dependent Schrodinger equation.
- Apply boundary conditions to find the set of possible states.
- Apply boundary conditions to obtain the spectra of the H- atom and identify the set of allowed values of the energy.
- Solving quantum problems by sing Scilab.

Evaluation Systems

	Component	***% of Marks***	***Method of Assessment***
Internal Examination	Midterm Test	*20*	Written examination
	Experiments	*30*	Lab work, report, viva
External Examination	Semester Examination	*30*	Written examination
	Experiments	*20*	Lab work, report, viva
Total		*100*	

Course Outline

Module I

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.

Module-II

Eigenvalues and Eigenfunctions. Position, momentum and Energy operators; commutator of position and momentum operators; Expectation values of position and momentum. Wave Function of a Free Particle.
Time independent Schrodinger equation-Hamiltonian, stationary states and energyeigenvalues; expansion of an arbitrary wavefunction as a linear combination of energy eigenfunctions;

Module-III

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.

Module IV

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; ground state, zero point energy & uncertainty principle.

Module-V

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.

Module VI

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.

Module-VII

Many electron atoms: Pauli's Exclusion Principle. Symmetric &Antisymmetric WaveFunctions. Periodic table. Fine structure. Spin orbit coupling. Spectral Notations for Atomic States. Total angular momentum. Vector Model. Spin-orbit coupling in atoms-L-S and J-J couplings. Hund's Rule. Term symbols. Spectra of Hydrogen.

Text Books:

1. Quantum Mechanics by Satya Prakash
2. Atomic and Molecular Physics: Laser by RajKumar

Reference Books:

1. A Text book of Quantum Mechanics, P.M.Mathews and K.Venkatesan, 2nd Ed., 2010, McGraw Hill
2. Quantum Mechanics, G. Aruldhas, 2ndEdn. 2002, PHI Learning of India
3. Quantum Mechanics, Robert Eisberg and Robert Resnick, 2ndEdn., 2002, Wiley.
4. Quantum Mechanics, Leonard I. Schiff, 3rdEdn. 2010, Tata McGraw Hill.

5. Quantum Mechanics, Bruce Cameron Reed, 2008, Jones and Bartlett Learning.
6. Quantum Mechanics: Foundations & Applications, Arno Bohm, 3rdEdn., 1993, Springer
7. Quantum Mechanics for Scientists & Engineers, D.A.B. Miller, 2008, Cambridge University Press

Additional Books for Reference

1. Quantum Mechanics, EugenMerzbacher, 2004, John Wiley and Sons, Inc.
2. Introduction to Quantum Mechanics, D.J. Griffith, 2nd Ed. 2005, Pearson Education
3. Quantum Mechanics, Walter Greiner, 4thEdn., 2001, Springer

Quantum Mechanics Lab

Any 8 experiments of the followings to be done.

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:

$$\frac{d^2y}{dr^2} = A(r)U(r), A(r) = \frac{2m}{\hbar^2}[V(r) - E] \quad \text{where} \quad V(r) = -\frac{e^2}{r}$$

Here, m is the reduced mass of the electron. 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 = 0.511x10^6 eV/c^2.

2. Solve the s-wave radial Schrodinger equation for an atom:

$$\frac{d^2y}{dr^2} = A(r)U(r), A(r) = \frac{2m}{\hbar^2}[V(r) - E]$$

where m is the reduced mass of the system (which can be chosen to be the mass of an electron), for the screened coulomb potential

$$V(r) = -\frac{e^2}{r}e^{-r/a}$$

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 = 0.511x10^6 eV/c^2, 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:

$$\frac{d^2y}{dr^2} = A(r)U(r), A(r) = \frac{2m}{\hbar^2}[V(r) - E]$$

For the anharmonic oscillator potential

$$V(r) = \frac{1}{2}kr^2 + \frac{1}{3}br^3$$

for the ground state energy (in MeV) of particle to an accuracy of three significant digits. Also, plot the corresponding wave function. Choose m = 940 MeV/c^2, k = 10 MeV 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.

1. Solve the s-wave radial Schrodinger equation for the vibrations of hydrogen molecule:

$$\frac{d^2y}{dr^2} = A(r)U(r), A(r) = \frac{2\mu}{\hbar^2}[V(r) - E]$$

Where □ is the reduced mass of the two-atom system for the Morse potential

$$V(r) = D(e^{-2\alpha r'} - e^{-\alpha r'})$$

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 = 940x10^{6}eV/C^2, D = 0.755501 eV, α = 1.44, ro = 0.131349 Å

Laboratory based experiments:

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

Text Books:

1. Schaum's outline of Programming with C++. J.Hubbard, 2000,McGraw-Hill Publication

Reference Books

2. Numerical Recipes in C: The Art of Scientific Computing, W.H. Pressetal., 3rdEdn., 2007, Cambridge University Press.
3. An introduction to computational Physics, T.Pang, 2nd Edn.,2006, Cambridge Univ. Press
4. Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific & Engineering Applications: A. VandeWouwer, P. Saucez, C. V. Fernández.2014 Springer.
5. Scilab (A Free Software to Matlab): H. Ramchandran, A.S. Nair. 2011 S. Chand & Co.
6. A Guide to MATLAB, B.R. Hunt, R.L. Lipsman, J.M. Rosenberg, 2014, 3rdEdn., Cambridge University Press
7. Scilab Image Processing: L.M.Surhone.2010 Betascript Publishing ISBN:978-6133459274

BSPH3502 Solid State Physics

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
Solid State Physics	**BSPH3502**	**Theory + Practice**	**4-2-0**	**Nil**

Objective

- Basic understanding of symmetry, electronic and thermodynamic properties of solid state systems and their technological applications.
- To impart knowledge of basic theories of the electronic structure of materials.
- Students should learn how to understand physical behavior of solids and electronic devices.

Learning Outcome

Upon successful completion of this course, students will be able to:

- Understand the elastic properties of solids and lattice vibration.
- Have an understanding of the magnetic properties of condensed matter.
- Have an understanding of the optical properties of solids and the relation to their electronic properties.
- Develop the facility for problems associated with the solid state with respect to semi-conductor physics.
- Outline the importance of solid state physics in the modern society.

Evaluation Systems

	Component	***% of Marks***	***Method of Assessment***
Internal Examination	Midterm Test	*20*	Written examination
	Experiments	*30*	Lab work, report, viva
External Examination	Semester Examination	*30*	Written examination
	Experiments	*20*	Lab work, report, viva
Total		*100*	

Course Outline

Module I

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

Module-II

Elementary Lattice Dynamics: Lattice Vibrations and Phonons: Linear Monoatomic and Diatomic Chains. Acoustical and Optical Phonons. Qualitative Description of the

Phonon Spectrum in Solids. Dulong and Petit's Law, Einstein and Debye theories of specific heat of solids (no derivation, concept only)

Module III

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

Module-IV

Dielectric Properties of Materials: Polarization. Local Electric Field at an Atom.Depolarization Field. Electric Susceptibility. Polarizability. ClausiusMosotti Equation. Classical Theory of Electric Polarizability. Normal and Anomalous Dispersion. Cauchy and Sellmeir relations. Langevin-Debye equation. Complex Dielectric Constant. Optical Phenomena.

Module-V

Ferroelectric Properties of Materials: Structural phase transition, Classification ofcrystals, Piezoelectric effect, Pyroelectric effect, Ferroelectric effect, Electrostrictive effect, Curie-Weiss Law, Ferroelectric domains, PE hysteresis loop.

Module VI

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.

Module-VII

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)

Text Books:

1. Solid State Physics, M.A. Wahab, 2011, Narosa Publications
2. Solid State Physics, S.O.Pilai
3. Solid State Physics, Gupta Kumar

Reference Books:

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

Solid State Physics Lab

Atleast any 8 of the followings to be done.

Measurement of susceptibility of paramagnetic solution (Quinck`s Tube Method)

To measure the Magnetic susceptibility of Solids.

To determine the Coupling Coefficient of a piezoelectric crystal.

1. To measure the Dielectric Constant of a dielectric Materials with frequency
2. To determine the complex dielectric constant and plasma frequency of metal using Surface Plasmon resonance (SPR)
3. To determine the refractive index of a dielectric layer using SPR
4. To study the PE Hysteresis loop of a Ferroelectric Crystal.
5. To draw the BH curve of Fe using Solenoid & determine energy loss from Hysteresis.
6. To measure the resistivity of a semiconductor (Ge) with temperature by four-probe method (room temperature to 150 ^{o}C) and to determine its band gap.
7. 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, KitabMahal

Elements of Solid State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice-Hall of India.

BSPH3601 Electromagnetic Theory

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
Electromagnetic Theory	**BSPH3601**	**Theory + Practice**	**4-2-0**	**Nil**

Objective

- To provide the basic skills required to understand, develop, and design various engineering applications involving electromagnetic fields.
- To lay the foundations of electromagnetism and its practice in modern communications such as wireless, guided wave principles such as fiber optics and electronic electromagnetic structures.
- To understand the transverse nature of light.

Learning Outcome

Upon successful completion of this course, students will be able to:

- Apply vector calculus to static electric-magnetic fields in different engineering situations.
- Analyze Maxwell's equation in different forms.
- Examine the phenomena of wave propagation in different media and its interfaces and in applications of microwave engineering.

Evaluation Systems

	Component	***% of Marks***	***Method of Assessment***
Internal Examination	Midterm Test	*20*	Written examination
	Experiments	*30*	Lab work, report, viva
External Examination	Semester Examination	*30*	Written examination
	Experiments	*20*	Lab work, report, viva
Total		*100*	

Course Outline

Module I

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.

Module-II

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.

Module III

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.

Module-IV

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.

Module V

Polarization continued…..

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.

Module-VI

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

Module-VII

Optical Fibres:-Numerical Aperture. Step and Graded Indices (Definitions Only).
Single and Multiple Mode Fibres (Concept and Definition Only).

Text Books:

- Introduction to Electrodynamics, D.J. Griffiths, 3rd Ed., 1998, Benjamin Cummings.

Reference Books:

1. Electrodynamics by Satya Prakash
2. A textbook of Optics ,BrijlalSubramanyam

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

Electromagnetic Lab

Atleast any 8 of the followings to be done.

1. To verify the law of Malus for plane polarized light.
2. To determine the specific rotation of sugar solution using Polarimeter.
3. To analyze elliptically polarized Light by using a Babinet's compensator.
4. To study dependence of radiation on angle for a simple Dipole antenna.
5. To determine the wavelength and velocity of ultrasonic waves in a liquid (Kerosene Oil, Xylene, etc.) by studying the diffraction through ultrasonic grating.
6. To study the reflection, refraction of microwaves
7. To study Polarization and double slit interference in microwaves.
8. To determine the refractive index of liquid by total internal reflection using Wollaston's air-film.
9. To determine the refractive Index of (1) glass and (2) a liquid by total internal reflection using a Gaussian eyepiece.
10. To study the polarization of light by reflection and determine the polarizing angle for air-glass interface.
11. To verify the Stefan`s law of radiation and to determine Stefan's constant.
12. To determine the Boltzmann constant using V-I characteristics of PN junction diode.

Text Books

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.

Reference Books:

1. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
2. A Text Book of Practical Physics, I.Prakash& Ramakrishna, 11th Ed., 2011, KitabMahal
3. Electromagnetic Field Theory for Engineers & Physicists, G. Lehner, 2010, Springer

BSPH3602 Statistical Mechanics

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
Statistical Mechanics	**BSPH3602**	**Theory + Practice**	**4-2-0**	**Nil**

Objective

- To make the students learn about macro and micro canonical calculations.
- Study of classical statistics i. e., understanding a system from its constituents.
- Study of classical theory of radiation.
- Study of Quantum theory of radiation

Learning Outcome

Upon successful completion of this course, students will be able to:

- Understand the basic properties of thermodynamics and statistical mechanics.
- After completion of course the students are able understand the blackbody radiation and distribution function.
- Distinguish between classical and quantum radiation.

Evaluation Systems

	Component	***% of Marks***	***Method of Assessment***
Internal Examination	Midterm Test	*20*	Written examination
	Experiments	*30*	Lab work, report, viva
External Examination	Semester Examination	*30*	Written examination
	Experiments	*20*	Lab work, report, viva
Total		*100*	

Course Outline

Module I

Classical Statistics: Macrostate & Microstate, Elementary Concept of Ensemble, Phase Space, Entropy and Thermodynamic Probability, Maxwell-Boltzmann Distribution Law, Partition Function, Thermodynamic Functions of an Ideal Gas,

Module II

Classical Entropy Expression, Gibbs Paradox, Sackur Tetrode equation, Law of Equipartition of Energy (with proof) – Applications to Specific Heat and its Limitations.

Module III

Classical Theory of Radiation: Properties of Thermal Radiation. Blackbody Radiation.Pure temperature dependence. Kirchhoff's law. Stefan-Boltzmann law: Thermodynamic proof.

Module IV

Radiation Pressure. Wien's Displacement law. Wien's Distribution Law. Saha's Ionization Formula. Rayleigh-Jean's Law. Ultraviolet Catastrophe.

Module V

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.

Module VI

Bose-Einstein Statistics: B-E distribution law, Thermodynamic functions of a stronglyDegenerate Bose Gas, Bose Einstein condensation, properties of liquid He (qualitative description), Radiation as a photon gas and Thermodynamic functions of photon gas.

Module VII

Fermi-Dirac Statistics: Fermi-Dirac Distribution Law, Thermodynamic functions of a Completely and strongly Degenerate Fermi Gas, Fermi Energy, Electron gas in a Metal.

Text Books:

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

Reference Books:

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

Statistical Mechanics Lab

Any 4 of the followings to be done.

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:
   i. Study of local number density in the equilibrium state (i) average; (ii) fluctuations
   ii. Study of transient behavior of the system (approach to equilibrium)
   iii. Relationship of large N and the arrow of time
   iv. Computation of the velocity distribution of particles for the system and comparison with the Maxwell velocity distribution
   v. Computation and study of mean molecular speed and its dependence on particle mass
   vi. Computation of fraction of molecules in an ideal gas having speed near the most probable speed
2. Computation of the partition function Z(β) 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(β), average energy <E>, 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
   Maxwell-Boltzmann distribution
   Fermi-Dirac distribution
   Bose-Einstein distribution

Text Books:

1. Elementary Numerical Analysis, K.E.Atkinson, 3rd Edn. 2007, Wiley India Edition

Reference Books:

1. Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University Press.
2. Introduction to Modern Statistical Mechanics, D. Chandler, Oxford University Press, 1987
3. Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W. Sears and Gerhard L. Salinger, 1986, Narosa.
4. Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer

5. Statistical and Thermal Physics with computer applications, Harvey Gould and Jan Tobochnik, Princeton University Press, 2010.
6. Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A. VandeWouwer, P. Saucez, C. V. Fernández. 2014 Springer ISBN: 978-3319067896
7. Scilab by example: M. Affouf, 2012. ISBN: 978-1479203444
8. Scilab Image Processing: L.M.Surhone. 2010, Betascript Pub., ISBN: 978- 6133459274

Basket-2

Ability Enhancement Compulsory Course (AECC)

BSFL1101 ENGLISH

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
ENGLISH	**BSFL1101**	**Theory**	**2-0-0**	**Nil**

Objective

- To expose the students to a variety of self- instructional, learner- friendly modes of language learning.
- To enable them to learn better pronunciation through stress on word accent, intonation, and rhythm.
- To maintain good linguistic - through accuracy in grammar, pronunciation and vocabulary.

Learning Outcome

- Ability to communicate fluently in different business situation
- Effective oral and written communication
- Appropriate word usage with correct pronunciation
- Clarity of word stress and intonation.

Evaluation Systems

	Component	***% of Marks***	***Method of Assessment***
Internal Examination	Midterm Test	*30*	Written examination
	Assignment	*05*	Report and Presentation
	Attendance	*05*	Attendance percentage
	Total	***40***	
External Examination		***60***	Written examination
Total		*100*	

Course Outline

Module-I: Communication Skill

Communication: Definition, concept

Channels of Communication: Sender, receiver, channel, message, encoding, decoding, context, feedback

Verbal & Non-Verbal Communication: Spoken & written-advantages & disadvantages, Bias free English,

Formal & informal style.

Module-II: Communicative Grammar

Time, Tense & Aspect

Verbs of state & events

Modality

Active & Passive voice

Antonyms, Synonyms, Homonyms, one word substitutions & correction of errors

Module-III: Sounds of English

Length of vowels:

Long vowels as in the words feel, food, shoot, card etc.

Short vowels as in the words pen, sun, cut, shut, etc.

Consonants

Stress pattern

Intonation: Rising & Falling.

Text Book:

1. Effective technical communication by M.A.Rizvi

Reference Books:

1. Communicative English & Business Communication by R.K.Panda, J.Khuntia, M.Pati, Alok Publication.
2. Communicative Grammar of English Geoffery Leech

FCBS0101 ENVIRONMENTAL SCIENCE

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
ENVIRONMENTAL SCIENCE	**FCBS0101**	**Theory**	**2-0-0**	**Nil**

Objective

- To understand the concept of multi-disciplinary nature of Environmental Science where different aspects are dealt with a holistic approach.
- Students will develop a sense of community responsibility by becoming aware of environmental issues in the larger social context.
- One must be environmentally educated.

Learning Outcome

Upon successful completion of this course, students will be able to:

- Understand the natural environment and its relationships with human activities.
- Characterize and analyze human impacts on the environment.
- Integrate facts, concepts, and methods from multiple disciplines and apply to environmental problems.
- Design and evaluate strategies, technologies and methods for sustainable management of environmental systems and for the remediation or restoration of degraded environments.

Evaluation Systems

	Component	***% of Marks***	***Method of Assessment***
Internal Examination	Midterm Test	*30*	Written examination
	Assignment	*05*	Report and Presentation
	Attendance	*05*	Attendance percentage
	Total	***40***	
External Examination		***60***	Written examination
Total		*100*	

Course Outline

MODULE-I

Environment and its multidisciplinary nature; Need for public awareness; Renewable and non - renewable resources–forest, water, mineral, land, food and energy resources; Structure and function of ecosystems of forest, grass land, desert and aquatic types.

MODULE -II

Biodiversity and its conservation: Biodiversity at global, national and local levels; Threats to biodiversity - Habitat loss; wild life poaching and man - wildlife conflicts; Endangered and endemic species; conservation measures.

Causes, effects and control measures of pollution, air, water and noise pollution; Nuclear hazards; solid-waste management–Causes, effects and control measures; Management of disasters due to natural causes of floods, earthquakes, cyclones and landslides.

MODULE-III

Social issues and the environment; Sustainable environment, Water conservation measures; Rain water harvesting; Resettlement and rehabilitation of people; Climate change and global warming; Acid rain; Ozone layer depletion; water land reclamation; Consumerism and waste products; Features of Environment Protection Act, Air pollution and Control of Pollution Acts; Water Pollution and its Control Act. Effects of Pollution explosion on environment and public health; Need for value education to Protect environment and resources.

Text Book:

1. Anubhav Kaushik & C.P. Kaushik: Environmental Studies-New age International Publishers.

Reference Books:

1. Benny Joseph: Environmental Studies-Tata Mac Graw Hill
2. E. Bharucha: Text book of Environmental Studies for under graduate courses– Universities Press. (Book prepared by UGC Committee).

Basket-3+4

DSE COURSES (For Non Domain)

(Any four of the followings)

BSPH3503 Experimental Techniques

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
Experimental Techniques	**BSPH3503**	**Theory + Practice**	**4-2-0**	**Nil**

Objective

- To understand how to take measurements with accuracy and efficiency.
- To develop a greater understanding of the issues involved different types of measurements.
- To learn about transducers, impedance bridges and multimeter.

Learning Outcome

Upon successful completion of this course, the student will be able to:

- Understand the importance of accuracy in measurement.
- Understand the working and application of transducers.
- Learn about all these and LCR circuits by practice mode.

Evaluation Systems

	Component	***% of Marks***	***Method of Assessment***
Internal Examination	Midterm Test	*20*	Written examination
	Experiments	*30*	Lab work, report, viva
External Examination	Semester Examination	*30*	Written examination
	Experiments	*20*	Lab work, report, viva
Total		*100*	

Course Outline

Module I

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

Module II

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

Module III

Transducers & industrial instrumentation (working principle, efficiency, applications):

Static and dynamic characteristics of measurement Systems. Generalized performance of systems, Zero order first order, second order and higher order systems. Electrical, Thermal and Mechanical systems. Calibration.

Module IV

Transducers and sensors. Characteristics of Transducers. Transducers as electrical element and their signal conditioning. Temperature transducers: RTD, Thermistor, Thermocouples, Semiconductor type temperature sensors (AD590, LM35, LM75) and signal conditioning.

Module V Transducers continued

Linear Position transducer: Strain gauge, Piezoelectric. Inductance change transducer: Linear variable differential transformer (LVDT), Capacitance change transducers.

Module VI

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

Module VII

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

Sensors: Radiation Sensors: Principle of Gas filled detector, ionization chamber, scintillation detector

Text Books:

1. Measurement, Instrumentation and Experiment Design in Physics and Engineering, M. Sayer and A. Mansingh, PHI Learning Pvt. Ltd.

Reference Books:

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

Experimental Techniques Lab (30Hrs)

Atleast any 8 of the followings to be done.

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

Text Books:

1. Electronic circuits: Handbook of design and applications, U. Tietze and C. Schenk, 2008, Springer

Reference Books:

1. Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1990, Mc-Graw Hill
2. Measurement, Instrumentation and Experiment Design in Physics & Engineering, M. Sayer and A. Mansingh, 2005, PHI Learning.

BSPH3504 Embedded system: Introduction to Microcontrollers

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
Embedded system: Introduction to Microcontrollers	**BSPH3504**	**Theory + Practice**	**4-2-0**	**Nil**

Objective

- To make the student learn about the embedded system, its applications and challenges.
- To learn about microprocessor and microcontroller.
- To learn microprocessor programing.
- To learn about embedded system design and development.
- Practice mode learning for these topics.

Learning Outcome

Upon successful completion of this course, students will be able to:

- Understand embedded system and its application.
- Understands microprocessor based systems in detail.
- Gains knowledge about design and development of embedded system.

Evaluation Systems

	Component	***% of Marks***	***Method of Assessment***
Internal Examination	Midterm Test	*20*	Written examination
	Experiments	*30*	Lab work, report, viva
External Examination	Semester Examination	*30*	Written examination
	Experiments	*20*	Lab work, report, viva

Total		*100*	

Course Outline

Module I

Embedded system introduction: Introduction to embedded systems and generalpurpose computer systems, architecture of embedded system, classifications, applications and purpose of embedded systems, challenges & design issues in embedded systems, operational and non-operational quality attributes of embedded systems, elemental description of embedded processors and microcontrollers.

Review of microprocessors: Organization of Microprocessor based system, 8085μp pindiagram and architecture, concept of data bus and address bus, 8085 programming model, instruction classification, subroutines, stacks and its implementation, delay subroutines, hardware and software interrupts.

Module II

8051 microcontroller: Introduction and block diagram of 8051 microcontroller,architecture of 8051, overview of 8051 family, 8051 assembly language programming, Program Counter and ROM memory map, Data types and directives, Flag bits and Program Status Word (PSW) register, Jump, loop and call instructions.

Module III

8051 I/O port programming: Introduction of I/O port programming, pin out diagram of8051 microcontroller, I/O port pins description & their functions, I/O port programming in 8051 (using assembly language), I/O programming: Bit manipulation.

Module IV

Programming: 8051 addressing modes and accessing memory using various addressingmodes, assembly language instructions using each addressing mode, arithmetic and logic instructions, 8051 programming in C: for time delay & I/O operations and manipulation, for arithmetic and logic operations, for ASCII and BCD conversions.

Module V

Serial port programming with and without interrupt: Introduction to 8051 interrupts,programming timer interrupts, programming external hardware interrupts and serial communication interrupt, interrupt priority in the 8051.

Module VI

Interfacing 8051 microcontroller to peripherals: Parallel and serial ADC, DACinterfacing, LCD interfacing.

Programming Embedded Systems: Structure of embedded program, infinite loop,compiling, linking and locating, downloading and debugging.

Module VII

Embedded system design and development: Embedded system developmentenvironment, file types generated after cross compilation, disassembler/ decompiler, simulator, emulator and debugging, embedded product development life-cycle, trends in embedded industry.

Text Books:

1. Embedded Systems: Architecture, Programming & Design, R.Kamal, 2008,Tata McGraw Hill

Reference Books:

1. The 8051 Microcontroller and Embedded Systems Using Assembly and C, M.A. Mazidi, J.G. Mazidi, and R.D. McKinlay, 2nd Ed., 2007, Pearson Education India.
2. Embedded microcomputor system: Real time interfacing, J.W.Valvano, 2000, Brooks/Cole

3. Microcontrollers in practice, I. Susnea and M. Mitescu, 2005, Springer.
4. Embedded Systems: Design & applications, S.F. Barrett, 2008, Pearson Education India
5. Embedded Microcomputer systems: Real time interfacing, J.W. Valvano 2011, Cengage Learning

Embedded System: Introduction to Microcontrollers Lab

Atleast any 8 of the followings to be done.

8051 microcontroller based Programs and experiments

1. To find that the given numbers is prime or not.
2. To find the factorial of a number.
3. Write a program to make the two numbers equal by increasing the smallest number and decreasing the largest number.
4. Use one of the four ports of 8051 for O/P interfaced to eight LED's. Simulate binary counter (8 bit) on LED's .
5. Program to glow the first four LEDs then next four using TIMER application.
6. Program to rotate the contents of the accumulator first right and then left.
7. Program to run a countdown from 9-0 in the seven segment LED display.
8. To interface seven segment LED display with 8051 microcontroller and display 'HELP' in the seven segment LED display.
9. To toggle '1234' as '1324' in the seven segment LED display.
10. Interface stepper motor with 8051 and write a program to move the motor through a given angle in clock wise or counter clockwise direction.
11. Application of embedded systems: Temperature measurement, some information on LCD display, interfacing a keyboard.

Arduino based programs and experiments:

12. Make a LED flash at different time intervals.
13. To vary the intensity of LED connected to Arduino
14. To control speed of a stepper motor using a potential meter connected to Arduino
15. To display "PHYSICS" on LCD/CRO.

Text Books:

1. Embedded Systems: Architecture, Programming& Design, R.Kamal,]2008,Tata McGraw Hill

Reference Books:

1. The 8051 Microcontroller and Embedded Systems Using Assembly and C, M.A. Mazidi, J.G. Mazidi, and R.D. McKinlay, 2nd Ed., 2007, Pearson Education India.
2. Embedded Microcomputor System: Real Time Interfacing, J.W.Valvano, 2000, Brooks/Cole
3. Embedded System, B.K. Rao, 2011, PHI Learning Pvt. Ltd.
4. Embedded Microcomputer systems: Real time interfacing, J.W. Valvano 2011, Cengage Learning

BSPH3505 Physics of Devices and Communications

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
Physics of Devices and Communications	**BSPH3505**	**Theory + Practice**	**4-2-0**	**Nil**

Objective

- Learning about UJT, JEFT, MOS, MOSFET and CMOS.
- Learning about different types of filters.
- Learn about different techniques for processing of devices
- Learning about the digital data communication system, including both seriel and parallel communication. Also the detailed communication system.

Learning Outcome

Upon successful completion of this course, students will be able to:

- Understands the characteristics of JFET, MOSFET UJT etc.
- Design filters and rectifiers.
- Verify theorems and analyze several circuits by simulation.
- Take an analytical approach to problems in their future endeavors.

Evaluation Systems

	Component	***% of Marks***	***Method of Assessment***
Internal Examination	Midterm Test	*20*	Written examination
	Experiments	*30*	Lab work, report, viva
External Examination	Semester Examination	*30*	Written examination
	Experiments	*20*	Lab work, report, viva
Total		*100*	

Course Outline

Module I

Devices: Characteristic and small signal equivalent circuits of UJT and JFET. Metal-semiconductor Junction. Metal oxide semiconductor (MOS) device. Ideal MOS and Flat Band voltage. SiO2-Si based MOS. MOSFET– their frequency limits. Enhancement and Depletion Mode MOSFETS, CMOS. Charge coupled devices. Tunnel diode.

Module II

Power supply and Filters: Block Diagram of a Power Supply, Qualitative idea of C and L Filters. IC Regulators, Line and load regulation, Short circuit protection.

Module III

Active and Passive Filters, Low Pass, High Pass, Band Pass and band Reject Filters.

Multivibrators: Astable and MonostableMultivibrators using transistors.

Module IV

Phase Locked Loop (PLL): Basic Principles, Phase detector (XOR & edge triggered), Voltage Controlled Oscillator (Basics, varactor). Loop Filter– Function, Loop Filter Circuits, transient response, lock and capture. Basic idea of PLL IC (565 or 4046).

Module V

Processing of Devices: Basic process flow for IC fabrication, Electronic grade silicon.Crystal plane and orientation. Defects in the lattice. Oxide layer. Oxidation Technique for Si. Metallization technique. Positive and Negative Masks. Optical lithography. Electron lithography. Feature size control and wet anisotropic etching. Lift off Technique. Diffusion and implantation.

Module VI

Digital Data Communication Standards:

Serial Communications: RS232, Handshaking, Implementation of RS232 on PC.

Universal Serial Bus (USB): USB standards, Types and elements of USB transfers. Devices (Basic idea of UART).

Parallel Communications: General Purpose Interface Bus (GPIB), GPIB signals and lines, Handshaking and interface management, Implementation of a GPIB on a PC. Basic idea of sending data through a COM port.

Module VII

Introduction to communication systems: Block diagram of electronic communication system, Need for modulation. Amplitude modulation. Modulation Index. Analysis of Amplitude Modulated wave. Sideband frequencies in AM wave. CE Amplitude Modulator. Demodulation of AM wave using Diode Detector. Basic idea of Frequency, Phase, Pulse and Digital Modulation including ASK, PSK, FSK.

Text Books:

1. Electronic devices and integrated circuits, A.K. Singh, 2011, PHI Learning Pvt. Ltd.

Reference Books

1. Physics of Semiconductor Devices, S.M. Sze & K.K. Ng, 3rd Ed.2008, John Wiley & Sons
2. Op-Amps & Linear Integrated Circuits, R.A.Gayakwad,4 Ed. 2000,PHI Learning Pvt. Ltd

3. Electronic Devices and Circuits, A. Mottershead, 1998, PHI Learning Pvt. Ltd.
4. Electronic Communication systems, G. Kennedy, 1999, Tata McGraw Hill.
5. Introduction to Measurements & Instrumentation, A.K. Ghosh, 3rd Ed., 2009, PHI Learning Pvt. Ltd.
6. Semiconductor Physics and Devices, D.A. Neamen, 2011, 4th Edition, McGraw Hill
7. PC based instrumentation; Concepts & Practice, N.Mathivanan, 2007, Prentice-Hall of India

Physics of Devices and Communications Lab

Atleast any 8 of the followings to be done.

Experiments from both Section A and Section B:

Section-A

1. To design a power supply using bridge rectifier and study effect of C-filter.
2. To design the active Low pass and High pass filters of given specification.
3. To design the active filter (wide band pass and band reject) of given specification.
4. To study the output and transfer characteristics of a JFET.
5. To design a common source JFET Amplifier and study its frequency response.
6. To study the output characteristics of a MOSFET.
7. To study the characteristics of a UJT and design a simple Relaxation Oscillator.
8. To design an Amplitude Modulator using Transistor.
9. To design PWM, PPM, PAM and Pulse code modulation using ICs.
10. To design an Astablemultivibrator of given specifications using transistor.
11. To study a PLL IC (Lock and capture range).
12. To study envelope detector for demodulation of AM signal.
13. Study of ASK and FSK modulator.
14. Glow an LED via USB port of PC.
15. Sense the input voltage at a pin of USB port and subsequently glow the LED connected with another pin of USB port.

Section-B:

SPICE/MULTISIM simulations for electrical networks and electronic circuits

1. To verify the Thevenin and Norton Theorems.
2. Design and analyze the series and parallel LCR circuits
3. Design the inverting and non-inverting amplifier using an Op-Amp of given gain
4. Design and Verification of op-amp as integrator and differentiator
5. Design the 1st order active low pass and high pass filters of given cutoff frequency
6. Design a Wein`s Bridge oscillator of given frequency.
7. Design clocked SR and JK Flip-Flop`s using NAND Gates
8. Design 4-bit asynchronous counter using Flip-Flop ICs
9. Design the CE amplifier of a given gain and its frequency response.
10. Design an Astablemultivibrator using IC555 of given duty cycle.

Text Books:

1. Basic Electronics:A text lab manual, P.B. Zbar, A.P. Malvino, M.A.Miller,1994, Mc-Graw Hill

Reference Books

2. Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
3. Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.
4. OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4thedn., 2000, Prentice Hall.
5. Introduction to PSPICE using ORCAD for circuits & Electronics, M.H. Rashid, 2003, PHI Learning.
6. PC based instrumentation; Concepts & Practice, N.Mathivanan, 2007, Prentice-Hall of India

BSPH3506 Advanced Mathematical Physics-I

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
Physics of Devices and Communications	**BSPH3505**	**Theory + Practice**	**4-2-0**	**Nil**

Objective

- Studying detailed about vector space.
- State the definition of a linear transformation L from a vector space V to another vector space W. Give examples of linear transformations.
- Study of Matrix algebra.
- Understanding Tensor, tensor algebra and its application in

Learning Outcome

Upon successful completion of this course, the student will be able to:

- Know how to manipulate with vectors in Euclidean space.
- Explain tensor, different types of and its basic operations. Work with transformation of coordinates.
- Do Fourier expansion and use Fourier transforms to understand tensors.
- Using tensor in different topics of Physics.

Evaluation Systems

	Component	***% of Marks***	***Method of Assessment***
Internal Examination	Midterm Test	*20*	Written examination
	Experiments	*30*	Lab work, report, viva

External Examination	Semester Examination	*30*	Written examination
	Experiments	*20*	Lab work, report, viva
Total		*100*	

Course Outline

Module I

Linear Vector Spaces: Abstract Systems. Binary Operations and Relations. Introduction to Groups and Fields. Vector Spaces and Subspaces. Linear Independence and Dependence of Vectors. Basis and Dimensions of a Vector Space. Change of basis. Homomorphism and Isomorphism of Vector Spaces. Linear Transformations. Algebra ofLinear Transformations. Non-singular Transformations Representation of Linear Transformations by Matrices

Module II

Matrices: Addition and Multiplication of Matrices. Null Matrices. Diagonal, Scalar andUnit Matrices. Upper-Triangular and Lower-Triangular Matrices. Transpose of a Matrix. Symmetric and Skew-Symmetric Matrices. Conjugate of a Matrix. Hermitian and Skew-Hermitian Matrices. Singular and Non-Singular matrices. Orthogonal and UnitaryMatrices. Trace of a Matrix. Inner Product

Module III

Eigen-values and Eigenvectors. Cayley- Hamiliton Theorem. Diagonalization of Matrices. Solutions of Coupled Linear Ordinary Differential Equations. Functions of aMatrix.

Module IV

Cartesian Tensors: Transformation of Co-ordinates. Einstein's Summation Convention.Relation between Direction Cosines. Tensors. Algebra of Tensors. Sum, Difference and Product of Two Tensors. Contraction. Quotient Law of Tensors. Symmetric and Anti-symmetric Tensors. Invariant Tensors: Kronecker and Alternating Tensors. Association of Antisymmetric Tensor of Order Two and Vectors.

Module V

Vector Algebra and Calculus using Cartesian Tensors: Scalar and Vector Products, Scalar and Vector Triple Products. Differentiation. Gradient, Divergence and Curl of Tensor Fields. Vector Identities.

Module VI

Tensorial Formulation of Analytical Solid Geometry: Equation of a Line. Angle between Lines. Projection of a Line on another Line. Condition for Two Lines to be Coplanar. Foot of the Perpendicular from a Point on a Line. Rotation Tensor (No Derivation). Isotropic Tensors. Tensorial Character of Physical Quantities. Moment of Inertia Tensor. Stress and Strain Tensors: Symmetric Nature. Elasticity Tensor. Generalized Hooke's Law.

Module VII

General Tensors: Transformation of Co-ordinates. Minkowski Space. Contravariant & Covariant Vectors. Contravariant, Covariant and Mixed Tensors. Kronecker Delta and Permutation Tensors. Algebra of Tensors. Sum, Difference & Product of Two Tensors. Contraction. Quotient Law of Tensors. Symmetric and Anti-symmetric Tensors. Metric Tensor.

Text Books:

1. Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, and F.E. Harris, 1970, Elsevier

Reference Books:

1. Mathematical Tools for Physics, James Nearing, 2010, Dover Publications.
2. Modern Mathematical Methods for Physicists and Engineers, C.D. Cantrell, 2011, Cambridge University Press
3. Introduction to Matrices and Linear Transformations, D.T. Finkbeiner, 1978, Dover Pub.
4. Linear Algebra, W. Cheney, E.W.Cheney&D.R.Kincaid, 2012, Jones & Bartlett Learning
5. Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole
6. Mathematical Methods for Physicis& Engineers, K.F.Riley, M.P.Hobson, S.J.Bence, 3rd Ed., 2006, Cambridge University Press

Advanced Mathematical Physics-ILab (30Hrs)

Scilab/ C++ based simulations experiments based on Mathematical Physics problems like

1. Linear algebra:
    - Multiplication of two 3 x 3 matrices
    - Eigenvalue and eigenvectors of

$$\begin{pmatrix} 2 & 1 & 1 \\ 1 & 3 & 2 \\ 3 & 1 & 4 \end{pmatrix}, \begin{pmatrix} 1 & -i & 3+4i \\ +i & 2 & 4 \\ 3-4i & 4 & 3 \end{pmatrix}, \begin{pmatrix} 2 & -i & 2i \\ +i & 4 & 3 \\ -2i & 3 & 5 \end{pmatrix}$$

2. Orthogonal polynomials as eigenfunctions of Hermitian differential operators.
3. Determination of the principal axes of moment of inertia through diagonalization.
4. Vector space of wave functions in Quantum Mechanics: Position and momentum differential operators and their commutator, wave functions for stationary states as eigenfunctions of Hermitian differential operator.
5. Lagrangian formulation in Classical Mechanics with constraints.
6. Study of geodesics in Euclidean and other spaces (surface of a sphere, etc).
7. Estimation of ground state energy and wave function of a quantum system.

Text Books:

1. Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A. VandeWouwer, P. Saucez, C. V. Fernández. 2014 Springer ISBN: 978-3319067896

Reference Books:

1. Scilab by example: M. Affouf, 2012, ISBN: 978-1479203444
2. Scilab Image Processing: L.M.Surhone. 2010, Betascript Pub., ISBN: 978-6133459274

BSPH3507 Advanced Mathematical Physics –II

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
Advanced Mathematical Physics – II	**BSPH3507**	**Theory**	**6-0-0**	**Nil**

Objective

1. To learn advanced topics in Mathematical Physics, such as the elements of functional analysis, the elements of algebra and group theory and probabilities.
2. To solve problems within these topics and describe their significance in modern physics.
3. To be familiar with variational problems.
4. To learn Groups, subgroups, homomorphism, isomorphism and its applications.

Learning Outcome

Upon successful completion of this course, the student will be able to:

- Solve mathematical problems using analytical methods.
- Compute probabilities and conditional probabilities in appropriate ways.
- Model and solve real-world problems
- Determine whether a given set and binary operation form a group by checking group axioms.
- Recognize the relationships between mathematical theories and apply the same to solve physical real life problems.

Evaluation Systems

	Component	***% of Marks***	***Method of Assessment***
	Midterm Test	*30*	Written examination

Internal Examination	Assignment	*05*	Report and Presentation
	Attendance	*05*	Attendance percentage
	Total	***40***	
External Examination		***60***	Written examination
Total		*100*	

Course Outline

Module I

Calculus of Variations:

Variable Calculus: Variational Principle, Euler's Equation and its Application to Simple Problems. Geodesics. Concept of Lagrangian. Generalized co-ordinates. Definition of canonical moment,

Module II

Euler-Lagrange's Equations of Motion and its Applications to Simple Problems (e.g., Simple Pendulum and One dimensional harmonic oscillator).

Definition of Canonical Momenta. Canonical Pair of Variables.

Module III

Definition of Generalized Force: Definition of Hamiltonian (Legendre Transformation). Hamilton's Principle. Poisson Brackets and their properties. Lagrange Brackets and their properties**.**

Module IV

Group Theory:

Review of sets, Mapping and Binary Operations, Relation, Types of Relations.

Groups: Elementary properties of groups, uniqueness of solution, Subgroup, Centre of a group, Co-sets of a subgroup, cyclic group,

Module V

Permutation/Transformation. Homomorphism and Isomorphism of group. Normal and conjugate subgroups, Completeness and Kernel.

Some special groups with operators. Matrix Representations: Reducible and Irreducible

Module VI

Advanced Probability Theory:

Fundamental Probability Theorems. Conditional Probability, Bayes' Theorem, Repeated Trials, Binomial and Multinomial expansions. Random Variables and probability distributions, Expectation and Variance,

Module VII

Special Probability distributions: The binomial distribution, The poisson distribution, Continuous distribution: The Gaussian (or normal) distribution, The principle of least squares.

Text Books:

1. Mathematical Methods for Physicists: Weber and Arfken, 2005, Academic Press.

Reference Books:

1. Mathematical Methods for Physicists: A Concise Introduction: Tai L. Chow, 2000, Cambridge

Univ. Press.
2. Elements of Group Theory for Physicists by A. W. Joshi, 1997, John Wiley.
3. Group Theory and its Applications to Physical Problems by Morton Hamermesh, 1989, Dover
4. Introduction to Mathematical Physics: Methods & Concepts: Chun Wa Wong, 2012, Oxford University Press
5. Introduction to Mathematical Probability, J. V. Uspensky, 1937, McGraw-Hill.

BSPH3508 Classical Dynamics

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
Classical Dynamics	**BSPH3508**	**Theory**	**6-0-0**	**Nil**

Objective

- Study of Newtonian Mechanics Langrangian Mechanics and Hamiltonian Mechanics and solve problems related to physical situation using these dynamics.
- Study of special theory of Relativity by using four vector
- Study of fluid dynamics.

Learning Outcome

Upon successful completion of this course, students will be able to:

- Understand the variational principle and lagrangian mechanics over Newtonian mechanics.
- Use the generalized coordinates and momentum coordinates in mechanics.
- After study the special theory of relativity the students have some knowledge about four vectors.
- A general idea and understanding of fluid dynamics.

Evaluation Systems

	Component	*% of Marks*	*Method of Assessment*
Internal Examination	Midterm Test	*30*	Written examination
	Assignment	*05*	Report and Presentation
	Attendance	*05*	Attendance percentage
	Total	***40***	
External Examination		***60***	Written examination
Total		*100*	

Course Outline

Module I

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.

Module II

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

Module III

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.

Module IV

Small Amplitude Oscillations: Minima of potential energy and points of stableequilibrium, 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.

Module V

Special Theory of Relativity: Postulates of Special Theory of Relativity. LorentzTransformations. Minkowski space. The invariant interval, light cone and world lines. Space-time diagrams. Time - dilation, length contraction and twin paradox. Four-vectors: space-like, time-like and light-like.

Module VI

Four-velocity and acceleration. Metric and alternating tensors. Four-momentum 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.

Module VII

Fluid Dynamics: Density and pressure P in a fluid, an element of fluid and itsvelocity, 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.

Text Books:

1. Classical Mechanics, H.Goldstein, C.P. Poole, J.L. Safko, 3rdEdn. 2002,Pearson Education.

Reference Books

2. Mechanics, L. D. Landau and E. M. Lifshitz, 1976, Pergamon.
3. Classical Electrodynamics, J.D. Jackson, 3rdEdn., 1998, Wiley.
4. The Classical Theory of Fields, L.D Landau, E.M Lifshitz, 4thEdn., 2003, Elsevier.
5. Introduction to Electrodynamics, D.J. Griffiths, 2012, Pearson Education.
6. Classical Mechanics, P.S. Joag, N.C. Rana, 1stEdn., McGraw Hall.
7. Classical Mechanics, R. Douglas Gregory, 2015, Cambridge University Press.
8. Classical Mechanics: An introduction, Dieter Strauch, 2009, Springer.

Solved Problems in classical Mechanics, O.L. Delange and J. Pierrus, 2010, Oxford Press

BSPH3603 Applied Dynamics

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
Applied Dynamics	**BSPH3603**	**Theory + Practice**	**4-2-0**	**Nil**

Objective

- To initiate the students to the concepts, techniques and applications of non-linear dynamics and deterministic chaos in continuous and discrete systems
- To expose the students to various examples taken from Physical, Chemical and Biological sciences and to train them how to apply the techniques taught to analyse such systems
- To initiate the students to elementary concepts of Fluid Dynamics and various types of fluid flows

Learning Outcome

Upon successful completion of this course, students will be able to:

- develop a heuristic and wholistic understanding of dynamics occuring in Physical, Chemical and Biological systems
- apply tools of phase space dynamics to analyse system dynamics and chaos develop a basic understanding of Fluid Dynamics and apply the laws to elementary

problems of fluid dynamics

Evaluation Systems

	Component	*% of Marks*	*Method of Assessment*
Internal Examination	Midterm Test	*20*	Written examination
	Experiments	*30*	Lab work, report, viva
External Examination	Semester Examination	*30*	Written examination
	Experiments	*20*	Lab work, report, viva
Total		*100*	

Course Outline

Module I

Introduction to Dynamical systems: Definition of a continuous first order dynamical system. The idea of phase space, flows and trajectories. Simple mechanical systems as first order dynamical systems : the free particle, particle under uniform gravity, simple and damped harmonic oscillator. Sketching flows and trajectories in phase space; sketching variables as functions of time, relating the equations and pictures to the underlying physical intuition.

Other examples of dynamical systems –

In Biology: Population models e.g. exponential growth and decay, logistic growth, species competition, predator-prey dynamics, simple genetic circuits

Module II

In Chemistry: Rate equations for chemical reactions e.g. auto catalysis, bistability In Economics: Examples from game theory.

Illustrative examples from other disciplines.

Fixed points, attractors, stability of fixed points, basin of attraction, notion of qualitative analysis of dynamical systems, with applications to the above examples.

Computing and visualizing trajectories on the computer using software packages. Discrete dynamical systems. The logistic map as an example.

Module III

Introduction to Chaos and Fractals: Examples of 2-dimensional billiard, Projection of the trajectory on momentum space. Sinai Billiard and its variants. Computational visualization of trajectories in the Sinai Billiard. Randomization and ergodicity in the divergence of nearby phase space trajectories, and dependence of time scale of divergence on the size of obstacle. Electron motion in mesoscopic conductors as a chaotic billiard problem. Other examples of chaotic systems; visualization of their trajectories on the computer.

Module IV

Self-similarity and fractal geometry: Fractals in nature – trees, coastlines, earthquakes, etc. Need for fractal dimension to describe self-similar structure. Deterministic fractal vs. self-similar fractal structure. Fractals in dynamics – Serpinski gasket and DLA.

Module V

Chaos in nonlinear finite-difference equations- Logistic map: Dynamics from time series. Parameter dependence- steady, periodic and chaos states. Cobweb iteration. Fixed points. Defining chaos- aperiodic, bounded, deterministic and sensitive dependence on initial conditions. Period- Doubling route to chaos.

Module-VI

Elementary Fluid Dynamics: Importance of fluids: Fluids in the pure sciences, fluids in technology. Study of fluids: Theoretical approach, experimental fluid dynamics, computational fluid dynamics. Basic physics of fluids: The continuum hypothesis-concept of fluid element or fluid parcel;

Module VII

Definition of a fluid- shear stress; Fluid properties- viscosity, thermal conductivity, mass diffusivity, other fluid properties and equation of state; Flow phenomena- flow dimensionality, steady and unsteady flows, uniform & non-uniform flows, viscous & inviscid flows, incompressible & compressible flows, laminar and turbulent flows, rotational and irrotational flows, separated & unseparated flows. Flow visualization - streamlines, pathlines, Streaklines.

Text Books

1. Nonlinear Dynamics and Chaos, S.H. Strogatz, Levant Books, Kolkata, 2007

Reference Books:

2. Understanding Nonlinear Dynamics, Daniel Kaplan and Leon Glass, Springer.
3. An Introduction to Fluid Dynamics, G.K.Batchelor, Cambridge Univ. Press, 2002
4. Fluid Mechanics, 2nd Edition, L. D. Landau and E. M. Lifshitz, Pergamon Press,
5. Oxford, 1987.

Applied Dynamics Lab

Laboratory/Computing and visualizing trajectories using software such as Scilab, Maple, Octave, XPPAUT based on Applied Dynamics problems like

1. To determine the coupling coefficient of coupled pendulums.
2. To determine the coupling coefficient of coupled oscillators.
3. To determine the coupling and damping coefficient of damped coupled oscillator.
4. To study population models e.g. exponential growth and decay, logistic growth, species competition, predator-prey dynamics, simple genetic circuits.
5. To study rate equations for chemical reactions e.g. auto catalysis, bistability.
6. To study examples from game theory.
7. Computational visualization of trajectories in the Sinai Billiard.
8. Computational visualization of trajectories Electron motion in mesoscopic conductors as a chaotic billiard problem.
9. Computational visualization of fractal formations of Deterministic fractal.
10. Computational visualization of fractal formations of self-similar fractal.
11. Computational visualization of fractal formations of Fractals in nature – trees, coastlines, earthquakes.
12. Computational Flow visualization - streamlines, pathlines, Streaklines.

Text Books

1. Nonlinear Dynamics and Chaos, Steven H. Strogatz, Levant Books, Kolkata, 2007

Reference Books:

1. Understanding Nonlinear Dynamics, Daniel Kaplan and Leon Glass, Springer.
2. An Introduction to Fluid Dynamics, G.K.Batchelor, Cambridge Univ. Press, 2002
3. Fluid Mechanics, 2nd Edn, L.D.Landau& E.M. Lifshitz, Pergamon Press, Oxford, 1987
4. Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A. VandeWouwer, P. Saucez, C. V. Fernández. 2014 Springer ISBN: 978-3319067896
5. Scilab by example: M. Affouf, 2012, ISBN: 978-1479203444
6. Scilab Image Processing: L.M.Surhone. 2010, Betascript Pub., ISBN: 978-6133459274

BSPH3604 Communication System

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
Communication System	**BSPH3604**	**Theory + Practice**	**4-2-0**	**Nil**

Objective

- Understanding the electronics communication system.
- To learn about analog modulation and its applications.
- To learn digital pulse modulation in digital transmission.
- Students will be exposed to the communication and navigation systems like satellite communication and mobile telephony system.

Learning Outcome

Upon successful completion of this course, students will be able to:

- Overall idea about communication system, modulation, TRAI and concept of noise.

- Understand analog modulation system.
- Understand the satellite communication system and navigation system.
- Also understand the architecture of mobile communication system which will enable them for further study in this growing area.

Evaluation Systems

	Component	***% of Marks***	***Method of Assessment***
Internal Examination	Midterm Test	*20*	Written examination
	Experiments	*30*	Lab work, report, viva
External Examination	Semester Examination	*30*	Written examination
	Experiments	*20*	Lab work, report, viva
Total		*100*	

Course Outline

Module I

Electronic communication: Introduction to communication – means and modes. Needfor modulation. Block diagram of an electronic communication system. Brief idea of frequency allocation for radio communication system in India (TRAI). Electromagnetic communication spectrum, band designations and usage. Channels and base-band signals. Concept of Noise, signal-to-noise (S/N) ratio.

Module II

Analog Modulation: Amplitude Modulation, modulation index and frequency spectrum. Generation of AM (Emitter Modulation), Amplitude Demodulation (diode detector), Concept of Single side band generation and detection. Frequency Modulation (FM) and Phase Modulation (PM), modulation index and frequency spectrum, equivalence between FM and PM, Generation of FM using VCO, FM detector (slope detector), Qualitative idea of Super heterodyne receiver

Module III

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

Module IV

Digital Pulse Modulation: Need for digital transmission, Pulse Code Modulation,Digital Carrier Modulation Techniques, Sampling, Quantization and Encoding. Concept of Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), Phase Shift Keying (PSK), and Binary Phase Shift Keying (BPSK).

Module V

Introduction to Communication and Navigation systems:

Satellite Communication– Introduction, need, geosynchronous satellite orbits,geostationary satellite advantages of geostationary satellites. Satellite visibility, transponders (C - Band), path loss, ground station, simplified block diagram of earth station. Uplink and downlink.

Module VI

Mobile Telephony System – Basic concept of mobile communication, frequency bandsused in mobile communication, concept of cell sectoring and cell splitting, SIM number, IMEI number, need for data encryption,

Module VII

Architecture (block diagram) of mobile communication network, idea of GSM, CDMA, TDMA and FDMA technologies, simplified block diagram of mobile phone handset, 2G, 3G and 4G concepts (qualitativeonly)

GPS navigation system (qualitative idea only)

Text Books:

1. Electronic Communications, D. Roddy and J. Coolen, Pearson Education India.

Reference Books

1. Advanced Electronics Communication Systems- Tomasi, 6th edition, Prentice Hall.
2. Electronic Communication systems, G. Kennedy, 3rdEdn., 1999, Tata McGraw Hill.
3. Principles of Electronic communication systems – Frenzel, 3rd edition, McGraw Hill
4. Communication Systems, S. Haykin, 2006, Wiley India
5. Electronic Communication system, Blake, Cengage, 5th edition.
6. Wireless communications, Andrea Goldsmith, 2015, Cambridge University Press

Communication Electronics Lab

1. To design an Amplitude Modulator using Transistor
2. To study envelope detector for demodulation of AM signal
3. To study FM - Generator and Detector circuit
4. To study AM Transmitter and Receiver
5. To study FM Transmitter and Receiver
6. To study Time Division Multiplexing (TDM)
7. To study Pulse Amplitude Modulation (PAM)
8. To study Pulse Width Modulation (PWM)
9. To study Pulse Position Modulation (PPM)
10. To study ASK, PSK and FSK modulators

Text Books:

1. Electronic Communication systems, G. Kennedy, 1999, Tata McGraw Hill.

Reference Books

1. Electronic Communication system, Blake, Cengage, 5th edition.

BSPH3605 Nuclear and Particle Physics

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
Nuclear and Particle Physics	**BSPH3605**	**Theory**	**6-0-0**	**Nil**

Objective

- Learn about Nuclei in detail – structure, properties, energy, momentum etc.
- To learn about several nuclear models.
- Learn about radioactive decay, nuclear reaction and its interaction with matter.
- Study different types of detectors for nuclear radiation detections.
- Learn about different particle accelerators.

Learning Outcome

Upon successful completion of this course, students will be able to:

- Know about nucleus, its properties and behavior in detail.
- Learn about Nuclear models.
- Understand the nuclear dacay, nuclear reaction, radiation and its interaction with matter. This will enable them to understand the Nuclear Physics closely.
- Gain knowledge about detectors and accelerators in nuclear physics.

Evaluation Systems

	Component	***% of Marks***	***Method of Assessment***
Internal Examination	Midterm Test	*30*	Written examination
	Assignment	*05*	Report and Presentation
	Attendance	*05*	Attendance percentage
	Total	***40***	
External Examination		***60***	Written examination
Total		*100*	

Course Outline

Module I

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

Module II

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

Module III

Radioactivity decay:(a) Alpha decay: basics ofα-decay processes, theory ofα-emission, Gamow factor, Geiger Nuttall law, α-decay spectroscopy. (b) γ-decay: energy

Kinematics for γ-decay, positron emission, electron capture, neutrino hypothesis. (c) Gamma decay: Gamma rays emission & kinematics, internal conversion.

Module IV

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).

Module V

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.

Module VI

Detector for Nuclear Radiations: Gas detectors: estimation of electric field, mobilityof 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.

Module VII

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

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 quark model, color quantum number and gluons.

Text Books:

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

Reference Books

1. Concepts of nuclear physics by Bernard L. Cohen. (Tata Mcgraw Hill, 1998).
2. Introduction to the physics of nuclei & particles, R.A. Dunlap. (Thomson Asia, 2004).
3. Introduction to High Energy Physics, D.H. Perkins, Cambridge Univ. Press
4. Introduction to Elementary Particles, D. Griffith, John Wiley & Sons
5. Quarks and Leptons, F. Halzen and A.D. Martin, Wiley India, New Delhi

6. Basic ideas and concepts in Nuclear Physics - An Introductory Approach by K. Heyde (IOP-Institute of Physics Publishing, 2004).
7. Radiation detection and measurement, G.F. Knoll (John Wiley & Sons, 2000).
8. Physics and Engineering of Radiation Detection, Syed Naeem Ahmed (Academic Press, Elsevier, 2007).
9. Theoretical Nuclear Physics, J.M. Blatt &V.F.Weisskopf (Dover Pub.Inc., 1991)

BSPH3606 Astronomy & Astrophysics

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
Astronomy & Astrophysics	**BSPH3606**	**Theory**	**6-0-0**	**Nil**

Objective

- To initiate the students to various coordinate systems, scales and techniques of Positional Astronomy, various types of telescopes (mounts, detectors etc) and their uses
- To expose the students to the studies of stars (Sun and other stars) their classification and use of laws of Mechanics and Optics to study these stars
- To initiate the students to laws of Gravitation and show how it applies to large scale structures of the Universe like galaxies and galactic clusters

Learning Outcome

Upon successful completion of this course, students will be able to:

- read and appreciate star charts, relate different coordinate systems used in astronomy and distinguish between various types of telescopes, their anatomy and working principles
- appreciate the dynamics and mechanisms of stars, their classification, the life cycle of stars
- have elementary ideas on galaxies, galactic structures, their dynamics and evolution

Evaluation Systems

	Component	***% of Marks***	***Method of Assessment***
Internal Examination	Midterm Test	*30*	Written examination
	Assignment	*05*	Report and Presentation
	Attendance	*05*	Attendance percentage
	Total	***40***	

External Examination		***60***	Written examination
Total		*100*	

Course Outline

Module I

Astronomical Scales: Astronomical Distance, Mass and Time, Scales, Brightness,Radiant Flux and Luminosity, Measurement of Astronomical Quantities Astronomical Distances, Stellar Radii, Masses of Stars, Stellar Temperature.

Basic concepts of positional astronomy: Celestial Sphere, Geometry of a Sphere, Spherical Triangle, Astronomical Coordinate Systems, Geographical Coordinate Systems, Horizon System, Equatorial System, Diurnal Motion of the Stars, Conversion of Coordinates. Measurement of Time, Sidereal Time, Apparent Solar Time, Mean Solar Time, Equation of Time, Calendar. Basic Parameters of Stars: Determination of Distance by Parallax Method; Brightness, Radiant Flux and Luminosity, Apparent and Absolute magnitude scale, Distance Modulus; Determination of Temperature and Radius of a star; Determination of Masses from Binary orbits; Stellar Spectral Classification, Hertzsprung-Russell Diagram.

Module II

Astronomical techniques: Basic Optical Definitions for Astronomy (Magnification Light Gathering Power, Resolving Power and Diffraction Limit, Atmospheric Windows), Optical Telescopes (Types of Reflecting Telescopes, Telescope Mountings, Space Telescopes, Detectors and Their Use with Telescopes (Types of Detectors, detection Limits with Telescopes).

Module III

Physical principles: Gravitation in Astrophysics (Virial Theorem, Newton versus Einstein), Systems in Thermodynamic Equilibrium.

The sun (Solar Parameters, Solar Photosphere, Solar Atmosphere, Chromosphere.Corona, Solar Activity, Basics of Solar Magneto-hydrodynamics. Helioseismology).

Module IV

The solar family (Solar System: Facts and Figures, Origin of the Solar System: The Nebular Model, Tidal Forces and Planetary Rings, Extra-Solar Planets.

Stellar spectra and classification Structure (Atomic Spectra Revisited, Stellar Spectra,Spectral Types and Their Temperature Dependence, Black Body Approximation, H R Diagram, Luminosity Classification)

Module V

The milky way : Basic Structure and Properties of the Milky Way, Nature of Rotation ofthe Milky Way (Differential Rotation of the Galaxy and Oort Constant, Rotation Curve of the Galaxy and the Dark Matter, Nature of the Spiral Arms), Stars and Star Clusters of the Milky Way, Properties of and around the Galactic Nucleus.

Module VI

Galaxies: Galaxy Morphology, Hubble's Classification of Galaxies, Elliptical Galaxies(The Intrinsic Shapes of Elliptical, de Vaucouleurs Law, Stars and Gas). Spiral and Lenticular Galaxies (Bulges, Disks, Galactic Halo) The Milky Way Galaxy, Gas and Dust in the Galaxy, Spiral Arms.

Module VII

Large scale structure & expanding universe: Cosmic Distance Ladder (An Example from Terrestrial Physics, Distance Measurement using Cepheid Variables), Hubble's Law (Distance- Velocity Relation), Clusters of Galaxies (Virial theorem and Dark Matter).

Text Books:

1. Modern Astrophysics, B.W. Carroll & D.A. Ostlie, Addison-Wesley Publishing Co.

Reference Books

1. Introductory Astronomy and Astrophysics, M. Zeilik and S.A. Gregory, 4th Edition, Saunders College Publishing.
2. The physical universe: An introduction to astronomy, F.Shu, Mill Valley: University Science Books.
3. Fundamental of Astronomy (Fourth Edition), H. Karttunen et al. Springer
4. K.S. Krishnasamy, 'Astro Physics a modern perspective,' Reprint, New Age International (p) Ltd, New Delhi,2002.
5. BaidyanathBasu, 'An introduction to Astro physics', Second printing, Prentice Hall of India Private limited, New Delhi, 2001.
6. Textbook of Astronomy and Astrophysics with elements of cosmology, V.B. Bhatia, Narosa Publication.

Course Outline

DEET0300 PROJECT

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
PROJECT WORK	DEET0300	Project	0-0-6	Nil

Skill Enhancement Courses (Any two of the following)

BSPH2001 Physics Workshop Skills

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
Physics Workshop Skills	BSPH2001	Practice	0-2-0	Nil

Objective

- Learn to use basic measuring tools like Vernier calipers, screw gauge and use of sextant.
- To learn some mechanical skills used in workshop.
- Learn to use basic electrical and electronics tools.

Learning Outcome

Upon successful completion of this course, the student will be able to:

- Make measurements with Vernier calipers, screw gauge and sextant.

- Learn to do different types of welding, drilling, cutting metal sheets, milling, drilling etc.
- Learn to use multimeter. Student can do soldering. Operate an oscilloscope.
- Can make regulated power supply.
- Can make timer circuit and electronic switch.

Evaluation Systems

	Component	***% of Marks***	***Method of Assessment***
Internal Examination	Experiments	*100*	Lab work, report, viva

Course Outline

Module-I (20Hrs)

Introduction: Measuring units. Conversion to SI and CGS. Familiarization with meter scale, Vernier calliper, 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.

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.

Module-II (10Hrs)

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.

Text Books:

1. A text book in Electrical Technology - B L Theraja – S. Chand and Company

Reference Books.

1. Performance and design of AC machines – M.G. Say, ELBS Edn.
2. Mechanical workshop practice, K.C. John, 2010, PHI Learning Pvt. Ltd.
3. Workshop Processes, Practices and Materials, Bruce J Black 2005, 3rdEdn., Editor Newnes [ISBN: 0750660732]
4. New Engineering Technology, Lawrence Smyth/Liam Hennessy, The Educational Company of

Ireland [ISBN: 0861674480]

BSPH2002 Computational Physics Skills

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
Computational Physics Skills	BSPH2002	Practice	0-2-0	Nil

Objective

- To expose the students to the **necessity** and the **benefits** of using computers and computational methods in solving problem of Physics
- To expose the students to the syntax of FORTRAN-77 and to train them to write FORTRAN-77 programs to solve elementary Physics problems like Simple Harmonic Motion (in both x- and y-directions), Projectile Motion etc
- To initiate the students to methods of data visualization using open source graphics packages like Gnuplot and train them to plot graphs for various data files
- To initiate the students to concept and practice of word processing (developing scientific documents) using open source software LaTeX

Outcome

Upon successful completion of this course, the student will be able to:

- appreciate the usefulness of computers as problem solving tools to solve problems of Physics
- write elementary programs in FORTRAN-77 language to solve B.Sc. Level problems of particle motion (Simple Harmonic Motion, Projectile Motion etc.)
- plot graphs using Gnuplot for given data sets or for data generated and saved by programs (e.g., programs which numerically solve problems of motion of different types
- write scientific reports of experiments done, data processed using LaTeX

Evaluation Systems

	Component	*% of Marks*	*Method of Assessment*
Internal Examination	Experiments	*100*	Lab work, report, viva

Course Outline

Module-I (15Hrs)

Introduction: Importance of computers in Physics, paradigm for solving physicsproblems for solution**.** Usage of Linux as an Editor. **Algorithms and Flowcharts:** Algorithm: Definition, properties and development. Flowchart: Concept of flowchart, symbols, guidelines, types. Examples: Cartesian to Spherical Polar Coordinates, Rootsof Quadratic Equation, Sum of two matrices, Sum and Product of a finite series, calculation of sin(x) as a series, algorithm for plotting (1) lissajous figures and (2) trajectory of a projectile thrown at an angle with the horizontal.

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

Control Statements: Types of Logic (Sequential, Selection, Repetition), BranchingStatements (Logical **IF**, Arithmetic IF, Block IF, Nested Block IF, SELECT CASE and ELSE IF Ladder statements), Looping Statements (DO-CONTINUE, DO-ENDDO, DO-WHILE, Implied and Nested DO Loops), Jumping Statements (Unconditional GOTO, Computed GOTO, Assigned GOTO) Subscripted Variables (Arrays: Types of Arrays, DIMENSION Statement, Reading and Writing Arrays), Functions and Subroutines (Arithmetic Statement Function, Function Subprogram and Subroutine), RETURN, CALL, COMMON and EQUIVALENCE Statements), Structure, Disk I/O Statements, open a file, writing in a file, reading from a file. Examples from physics problems.

Programming:

1. Exercises on syntax on usage of FORTRAN
2. Usage of GUI Windows, Linux Commands, familiarity with DOS commands and working in an editor to write sources codes in FORTRAN.
3. To print out all natural even/ odd numbers between given limits.
4. To find maximum, minimum and range of a given set of numbers.

5. Calculating Euler number using exp(x) series evaluated at x=1 **(6Hrs)**

Module-II (15Hrs)

Scientific word processing: Introduction to LaTeX: TeX/LaTeX word processor,preparing a basic LaTeX file, Document classes, preparing an input file for LaTeX, Compiling LaTeX File, LaTeX tags for creating different environments, Defining LaTeX commands and environments, changing the type style, Symbols from other languages. **Equation representation:** Formulae and equations, Figures and other floating bodies, Lining in columns- Tabbing and tabular environment, Generating table of contents, bibliography and citation, Making an index and glossary, List making environments, Fonts, Picture environment and colors, errors.

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

Hands on exercises: Atleast 6 of the followings.

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

Text Books:

1. Introduction to Numerical Analysis, S.S. Sastry, 5thEdn., 2012, PHI Learning Pvt. Ltd.

Reference Books

1. Computer Programming in FORTRAN 77". V. Rajaraman (Publisher: PHI).
2. LaTeX–A Document Preparation System", Leslie Lamport (Second Edition, Addison-Wesley, 1994).
3. Gnuplot in action: understanding data with graphs, Philip K Janert, (Manning 2010)
4. Schaum's Outline of Theory and Problems of Programming with FORTRAN, S Lipsdutz and A Poe, 1986Mc-Graw Hill Book Co.
5. Computational Physics: An Introduction, R. C. Verma, et al. New Age International Publishers, New Delhi(1999)
6. A first course in Numerical Methods, U.M. Ascher and C. Greif, 2012, PHI Learning

BSPH2003 Electrical Circuits and Network Skills

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
Electrical Circuits and Network Skills	**BSPH2003**	**Practice**	**0-2-0**	**Nil**

Objective

- To expose and train the students on various aspects of DC and AC circuits, circuit elements, measurements and networking
- To enable the students to design and trouble-shoot the electrical circuits, networks and appliances through hands-on mode

Learning Outcome

Upon successful completion of this course, the student will be able to:

- read and analyse circuits and networks
- design and trouble-shoot circuits and networks involving various appliances
- Design, analyse and trouble-shoot various types of electrical wiring in circuits and networks

Evaluation Systems

	Component	***% of Marks***	***Method of Assessment***
Internal Examination	Experiments	*100*	Lab work, report, viva

Course Outline

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

Module-I (15Hrs)

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

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

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.

Module-II (15Hrs)

Electric Motors: Single-phase, three-phase & DC motors. Basic design. Interfacing DCor AC sources to control heaters & motors. Speed & power of ac motor

Solid-State Devices: Resistors, inductors and capacitors. Diodeand rectifiers.

Components in Series or in shunt. Response of inductors and capacitors with DC or AC sources

ElectricalProtection: Relays. Fuses and disconnect switches. Circuitbreakers.

Overload devices. Ground-fault protection. Grounding and isolating. Phase reversal. Surge protection. Interfacing DC or AC sources to control elements (relay protection device)

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.

Text Books:

1. A text book in Electrical Technology - B L Theraja - S Chand & Co.

Reference Books

1. A text book of Electrical Technology - A K Theraja
2. Performance and design of AC machines - M G Say ELBS Edn.Elementary Numerical Analysis, K.E. Atkinson, 3rd Edn., 2007, Wiley India Edition.

BSPH2004 Basic Instrumentation Skills

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
Basic Instrumentation Skills	**BSPH2004**	**Practice**	**0-2-0**	**Nil**

Objective

- To provide a brief knowledge of measurements and measuring instruments related to engineering
- To get exposure with various aspects of instruments and their usage through hands-on mode.
- To make students learn the basics of multimeter, voltmeter, CRO and analysis instruments.

Learning Outcome

Upon successful completion of this course, the student will be able to:

- Apply the concepts of physics & electric/ electronics to measurement & control systems.
- Design and implement systems utilizing analog / digital control devices.
- Take measurements using digital and analog instruments.

Evaluation Systems

	Component	***% of Marks***	***Method of Assessment***
Internal Examination	Experiments	*100*	Lab work, report, viva

Course Outline

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

Module-I (15Hrs)

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

Electronic Voltmeter: Advantage over conventional multimeter for voltagemeasurement with respect to input impedance and sensitivity. Principles of voltage, measurement (block diagram only). Specifications of an electronic Voltmeter/ Multimeter and their significance.

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

Use of CRO for the measurement of voltage (dc and ac frequency, time period. Special features of dual trace, introduction to digital oscilloscope, probes.

Module-II (15Hrs)

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

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

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

Digital Multimeter: Block diagram and working of a digital multimeter. Workingprinciple of time interval, frequency and period measurement using universal counter/ frequency counter, time- base stability, accuracy and resolution.

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 alow 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)

Text Books:

1. A text book in Electrical Technology - B L Theraja - S Chand and Co.

Reference Books

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

BSPH2005 Applied Optics

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
Applied Optics	**BSPH2005**	**Practice**	**0-2-0**	**Nil**

Objective

- To make students learn about light sources and detectors in practice mode.
- To learn about Fourier optics, Holography and photonics – Fibre optics.
- To expose them to several experiments on the topics.

Learning Outcome

Upon successful completion of this course, the student will be able to:

2. Understand the principle and working of different light sources, detectors.
3. Know how and where to use Fourier optics, holography and photonics.
4. They will understand fibre optics and do experiments on it.

Evaluation Systems

	Component	***% of Marks***	***Method of Assessment***
Internal Examination	Experiments	*100*	Lab work, report, viva

Course Outline

Theory: 30Hrs

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

(i) Sources and Detectors (9Hrs)

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(6Hrs)

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(6Hrs)

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(9Hrs)

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.

Experiments on Photonics: Fibre Optics

1.To measure the numerical aperture of an optical fibre
2. To study the variation of the bending loss in a multimode fibre
3. To determine the mode field diameter (MFD) of fundamental mode in a single-mode fibre by measurements of its far field Gaussian pattern
3. To measure the near field intensity profile of a fibre and study its refractive index profile
4. To determine the power loss at a splice between two multimode fibre

Text Books:

1. Fundamental of optics, F. A. Jenkins & H. E. White, 1981, Tata McGraw hill.

Reference Books

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

Basket-5

Generic Elective (GE)

(Subjects from other Disciplines)