K.R. MANGALAM UNIVERSITY
THE COMPLETE WORLD OF EDUCATION

SCHOOL OF BASIC AND APPLIED SCIENCES

Master of Science Physics

M.Sc. Physics

Programme Code: 59

2020-22

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

Academic Council
Member Secretary
K.R. Mangalam University

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

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Preamble

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

In this regards board of studies meeting of School of Basic and Applied Sciences was conducted on 29 June 2021. The SBAS presented scheme of studies of M. Sc. Physics for the duration of 2021-2023 keeping in mind the vision of outcome based education and learning outcome curriculum framework. There are 16 core courses, 2 skill enhancement courses, and 2 discipline specific elective courses in the M. Sc. Physics programme. All the faculties of the SBAS as well as interdepartmental faculties have contributed in the design of courses. The SBAS acknowledges all the faculty members for their valuable contributions.

Prepared by:

Dr. Diwakar Padalia Associate Professor	Dr. Pawan Kumar Assistant Professor	Dr. Dilraj Preet Kaur Associate Professor
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1. Introduction

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

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

K. R. Mangalam University is unique because of its

- An enduring legacy of providing education to high achievers who demonstrate leadership in diverse fields.
- Protective and nurturing environment for teaching, research, creativity, scholarship, social and economic justice.

Objectives

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

2. About School

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

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

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

VISION

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

MISSION

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

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

M3: Create a conducive environment for lifelong learning.

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

3.Programmes offered by the School

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

4. M. Sc. Physics

The School offers postgraduate M.Sc. Physics since 2015. This programme emphasizes on hands on practice, innovative thought process and project-based learning.This programme aims to impart advance and applied knowledge in various branches in Physics with a view to produce good academics, researchers and professionals in the field.

Eligibility Criteria: - He/ She should have passed the B.Sc. (Hons.) Physics / B.Sc. with Physics as a major subject, from a recognized University or equivalent with minimum 50% marks in aggregate.
Course Outline: - Mathematical Physics / Classical Mechanics / Quantum Mechanics / Electronic Devices / Statistical Mechanics / Electrodynamics and Plasma Physics / Atomic and Molecular Physics / Condensed Matter / Nuclear and Particle Physics.
Career Options: - Academics, Industry and Government Research Organizations.

4. Program Duration

The minimum period required for the M.Sc. Program offered by the University shall extend over a period of two Academic Years.

The maximum period for the completion of the M.Sc. Program offered by the University shall be four years.

5. Class Timings

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

6. Scheme of Studies and Syllabi

The syllabi of M.Sc. Physics for all years offered by SBAS with scheme of studies are given in the following pages.

M.Sc. Physics Two Years Postgraduate Programme at a Glance

SEMESTER	I	II	III	IV	TOTAL
COURSES	7	7	6	5	**25**
CREDITS	21	21	22	22	**86**

I-SEMESTER								
YEAR	**S. NO.**	**COURSE CODE**	**COURSE TYPE**	**COURSE TITLE**	**L**	**T**	**P**	**C**
FIRST	1	BSPH701 A	CC-1	MATHEMATICAL METHOD OF PHYSICS-I	4	0	0	4
	2	BSPH703 A	CC-2	ELECTRONICS-I	4	0	0	4
	3	BSPH751 A	CC-2 LAB	ELECTRONICS LAB-I	0	0	4	2
	4	BSPH705 A	CC-3	CLASSICAL MECHANICS-I	4	0	0	4
	5	BSPH707 A	CC-4	NUCLEAR AND PARTICLE PHYSICS	4	0	0	4
	6	BSMA711 A	SEC-1	ADVANCED MATLAB PROGRAMMING	2	0	0	2
	7	BSMA771 A	SEC-1 LAB	ADVANCED MATLAB PROGRAMMING LAB	0	0	2	1
	TOTAL				**18**	**0**	**6**	**21**

II-SEMESTER								
YEAR	**S. NO.**	**COURSE CODE**	**COURSE TYPE**	**COURSE TITLE**	**L**	**T**	**P**	**C**
FIRST	1	BSPH702A	CC-5	MATHEMATICAL METHOD OF PHYSICS-II	4	0	0	4
	2	BSPH704A	CC-6	ELECTRONICS-II	4	0	0	4
	3	BSPH752A	CC-6 LAB	ELECTRONICS LAB-II	0	0	4	2
	4	BSPH706A	CC-7	CLASSICAL MECHANICS-II	4	0	0	4
	5	BSPH708A	CC-8	ADVANCED SOLID STATE PHYSICS-I	4	0	0	4
	6	BSPH754A	CC-8 LAB	ADVANCED SOLID STATE PHYSICS LAB-I	0	0	4	2
	7	BSMA776A	SEC-2 LAB	LATEX LAB	0	0	2	1
	TOTAL				**16**	**0**	**10**	**21**

III-SEMESTER								
YEAR	**S. NO.**	**COURSE CODE**	**COURSE TYPE**	**COURSE TITLE**	**L**	**T**	**P**	**C**
SECOND	1	BSPH801A	CC-9	ATOMIC AND MOLECULAR PHYSICS-I	4	0	0	4
	2	BSPH803A	CC-10	ADVANCED QUANTUM MECHANICS-I	4	0	0	4
	3	BSPH805A	CC-11	ADVANCED SOLID STATE PHYSICS -II	4	0	0	4
	4	BSPH851A	CC-11 LAB	ADVANCED SOLID STATE PHYSICS LAB-II	0	0	4	2
	5	BSPH807A	CC-12	ELECTRODYANAMICS	4	0	0	4
	6	BSPH809A	CC-13	THERMODYANAMICS AND STATISTICAL PHYSICS	4	0	0	4
	TOTAL				**20**	**0**	**4**	**22**

IV-SEMESTER								
YEAR	**S. NO.**	**COURSE CODE**	**COURSE TYPE**	**COURSE TITLE**	**L**	**T**	**P**	**C**
SECOND	1	BSPH802A	CC-14	ATOMIC AND MOLECULAR PHYSICS-II	4	0	0	4
	2	BSPH804A	CC-15	ADVANCED QUANTUM MECHANICS-II	4	0	0	4
	3	BSPH806A	CC-16	NANOTECHNOLOGY	4	0	0	4
	4	#	DSE-1	DISCPLINE ELECTIVE COURSE (DSE)	4	0	0	4
	5	BSPH812A	DSE-2	DISSERTATION	0	0	0	6
	TOTAL				**16**	**0**	**0**	**22**
	# Discipline Elective Courses (Choose any one)							
	1	BSPH808A	DSE-1	FABRICATION OF ELECTRONICS DEVICES	4	0	0	4
	2	BSPH810-A	DSE-1	LASER FUNDAMENTALS	4	0	0	4

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

COURSE TYPE	NOMENCLATURE
CC	CORE COURSE
SEC	SKILL ENHANCEMENT COURSE
DSE	DISCIPLINE SPECIFIC ELECTIVE

I-SEMESTER

BSPH701A	**MATHEMATICAL METHODS OF PHYSICS-I**	L	T	P	C
Version 2.0		4	0	0	4
Pre-requisites	Mathematical Physics-I				
Co-requisites					

Course Objectives

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

On completion of this course, the students will be able to:
CO1. Apply concepts of calculus in solving problems of interest to physicists.
CO2. Better understand vector calculus and its applications.
CO3. Understand use of vector differentiation and integration.
CO4. Solve equations encountered in Physics and Engineering.

This course aims to demonstrate the use of mathematical techniques in solving problems in Physics and to provide a deeper understanding of the mathematics underpinning theoretical physics. The course is intended to develop the concepts of vector calculus and its applications. Emphasis will be on illustrative examples from Physics and Engineering.

Course Content
UNIT-I Vector Algebra: 15 Lectures

scalar & vector product. geometrical interpretation. coplanarity.
Vector Calculus: differentiation of vectors. scalar and vector point function. gradient of a scalar function. normal and directional derivative. divergence and curl of a vector point function. line integral, surface integral, and volume integral. Stoke's theorem. Gauss' theorem of divergence.

UNIT-II Algebra of Matrices **15 Lectures**

definition. types of matrices. addition, subtraction and multiplication of matrices. Inverse of a matrices. Cayley-Hamilton Theorem. power of a matrices. Eigenvalues and eigenvectors. Diagonalisation. Rank of a matrices. Solution of simultaneous equations. Cramer's Rule. Linear dependence and independence of vectors.

UNIT-III Linear ordinary differential equations **15 Lectures**

first order: Order & degree of a differential equation. Formation of differential equations. Solution of a differential equation. Homogeneous differential equations.

Linear ordinary differential equations of second order: Wronskian. Complete solution, complementary function, particular integral.

UNIT-IV Special functions **15 Lectures**

Legendre's equation; Legendre's polynomials; Legendre’s function of the second kind; General solution of Legendre's equation; Rodrigue's formula; Recurrence formulae. Bessel's function: Bessel's equation; solution of Bessel's equation; Bessel's functions; Bessel's function of the second kind of order n; Recurrence formulae; Hermite Function: Hermite equation; Rodrigue formula (generating function of Hermite polynomials; Alternative expressions for the Hermite polynomials; Recurrence formulae. Laguerre’s Function: Laguerre's equation; Laguerre's function for different values of n; Generating function of Laguerre Polynomial; Recurrence relation; orthogonal property.

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

BSPH703A	**ELECTRONICS-I**	L	T	P	C
Version 2.0		4	0	0	4
Pre-requisites/Exposure	Basics of Electronics				
Co-requisites					

Course Objectives

1. Learn the basics of an operational amplifier.
2. Develop an understanding of different types of operational amplifier connections /configurations.
3. Practical applications of operational amplifier.
4. Gain the insight of the 555 timer and its working.

On completion of this course, the students will be able to:

CO1. Better understanding of working of IC741 operational amplifier (OP-AMP) which includes construction and configurations.
CO2. Development of different electronic circuits by using OP-AMP.
CO3. Comprehend the functioning of advanced IC555 which includes the construction and application parts.
CO4. Improve the circuit designing & analysis ability.

This course imparts the basic concepts of Operational Amplifiers (Op-Amp). Op amps are some of the most basic active components in analog systems. The course gives better insight about application part. Furthermore, with other external components, we can build waveform converters, oscillators, active filters, and other interesting circuits

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Course Contents

UNIT-I **15 Lectures**

Basic building blocks of linear integrated circuits, Operational Amplifiers (op-amps), circuit diagram, pin diagram of 741 IC, working of op-amp, open loop and closed loop configuration.

UNIT-II **15 Lectures**

Types of feedback circuits in op-amps (positive and negative feedback). Design of amplifiers and oscillators using different types of feedback circuits (series and shunt configuration).

UNIT-III **15 Lectures**

Various circuits based on op-amps such as adder, subtractor, differentiator, integrator, Zero Crossing detector, amplifiers, oscillators, Comparators, Schmitt trigger, Sine-wave generators, Triangular wave generator, Saw-tooth wave generator, filters (low pass filter, high pass filter, bandpass filter).

UNIT-IV **15 Lectures**

555 timer IC: circuit diagram, pin diagram, working, monostable, bistable and astable multivibrators etc.

- Robert Boylestad, Louis Nashelsky, Electronic Devices and Circuit Theory, 8Th Edition, Pearson Education, India.
- Albert P. Malvino, David J. Bates. Electronic Principles, Eighth Edition, McGraw-Hill Education, United States.
- Electronic Communication, Rudy and Cohlen (Prentice Hall).
- Semiconductor Devices Physics & Technology by S. M. Sze (John Wiley).

BSPH751A	**ELECTRONICS-I LAB**	L	T	P	C
Version 1.0		0	0	4	2
Pre-requisites/Exposure	Basics of Electronics				
Co-requisites					

Course Objectives

1. Learn the basic experimental knowledge of an operational amplifier.
2. Develop an understanding of different types of operational amplifier connections /configurations.
3. Practical applications of operational amplifier.
4. Gain the insight of the 555 timer and its working.

On completion of this course, the students will be able to:
CO1. Better functional understanding of working of IC741 operational amplifier (OP-AMP).
CO2. Development of different electronic circuits by using OP-AMP.
CO3. Comprehend the functioning of advanced IC555 which includes the construction and application parts.
CO4. Improve circuit designing & analysis ability.

This laboratory course imparts the advanced experimental concepts of Operational Amplifiers (Op-Amp). Op amps are some of the most basic active components in analog systems. The course gives better insight into the application part. Furthermore, with other external components, we can build waveform converters, oscillators, active filters, and other interesting circuits.

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1. Study of operational amplifiers, circuit diagram, pin diagram of 741 IC, working of op-amp, open loop and closed loop configuration.
2. Study of types of feedback circuits in op-amps (positive and negative feedback).

3. Design of amplifiers and oscillators using different types of feedback circuits (series and shunt configuration).

4. Design of various circuits based on op-amps such as adder, subtractor, differentiator, integrator
5. Design of zero Crossing detector, amplifiers, oscillators

6. Comparators, Schmitt trigger, Sine-wave generators, Triangular wave generator,

7. Study of saw-tooth wave generator, filters (low pass filter, high pass filter, bandpass filter).

8. Study of 555 timer IC: circuit diagram, pin diagram, working, monostable, bistable and astable multivibrators etc.

- Robert Boylestad, Louis Nashelsky, Electronic Devices and Circuit Theory, 8Th Edition, Pearson Education, India.
- Albert P. Malvino, David J. Bates. Electronic Principles, Eighth Edition, McGraw-Hill Education, United States.
- Electronic Communication, Rudy and Cohlen (Prentice Hall).
- Semiconductor Devices Physics & Technology by S. M. Sze (John Wiley).

BSPH705A	**CLASSICAL MECHANICS I**	L	T	P	C
Version 2.0		4	0	0	4
Pre-requisites/Exposure	Basic calculus skills				
Co-requisites					

Course Objectives

1. To understand the concept of Lagrangian formulation of mechanics.
2. To comprehend the Hamiltonian mechanics and application of Hamilton equations.
3. To acquire the knowledge of canonical transformations.
4. To gain the insight of moving coordinate systems and their effects.

On completion of this course, the students will be able to

CO1. The students will be able to understand the physics behind Lagrangian formulation and ways of solving different problems.
CO2. Enable students to know the significance of Hamilton equations in finding solutions to problems.
CO3. Explain the concept of canonical transformation.
CO4. Understand the moving coordinate systems and effect of Coriolis and centripetal forces.

This course imparts the understanding of constraints and the difficulty to obtain the solution using Newton laws and hence the need of understanding alternative methods to solve problems in mechanics. It imparts detailed study of Lagrangian and Hamiltonian formulation of mechanics , their respective equations of motion and implementation of such equations to solve problems. It assesses the different forms of Canonical transformations and their advantages. The course coherently covers the rotating frames and relative coordinate systems-importance of like Coriolis and centripetal force and their significant role in various phenomenon taking place on earth.

UNIT-I Lagrangian Formulation **15 Lectures**

Constraints and their classification, degrees of freedom and generalized coordinates, transformation equations, configuration space, virtual displacement and principle of virtual work, d'Alembert principle, Lagrange's equation of motion for conservative a nd non-conservative systems, Lagrange's equation for systems containing dissipative forces, Lagrangian formulation of conservation theorems- conservation of generalized momentum, energy, angular momentum, linear momentum and cyclic co-ordinates.

UNIT-II Hamiltonian Formulation: **15 Lectures**

Phase space, Hamiltonian function, physical significance of Hamiltonian, Hamilton`s equations, applications of Hamilton`s equations, variational principle (Euler-Lagrange equation), Hamilton`s principle, modified Hamilton`s principle, derivation of Hamilton equations from modified Hamilton`s principle, principle of least action.

UNIT-III Canonical transformation: **15 Lectures**

Canonical transformation equations and their advantage, condition for a transformation to be canonical, Poisson brackets and its properties, Lagrange bracket and itsproperties, relation between Poisson and Lagrange bracket.

UNIT-IV Moving Co-ordinate systems **15 Lectures**

Inertial and Non-Inertial systems, Galilean transformation, Galilean transformation for the velocity of the particle, rotating coordinate systems- Coriolis and centripetal forces, effect of Coriolis force on moving bodies on Earth, Foucault pendulum.

Text Books

- Classical Mechanics, Gupta, Kumar and Sharma.

Reference Books/Materials

- Classical Mechanics, N. C. Rana and P. S. Joag (Tata McGraw-Hill India).
- Classical Mechanics, S. N. Biswas (Books and Allied Ltd).
- Introduction to Classical Mechanics, Takwale and Puranik (Tata McGraw-Hill).
- Classical Mechanics, H. Goldstein (Narosa Publishing House).
- Classical Mechanics, Mondal (Prentice-Hall India).
- Classical Mechanics: A Modern Perspective, Barger & Olsson (McGraw Hill International)

BSPH707A	**NUCLEAR AND PARTICLE PHYSICS**	L	T	P	C
Version 2.0		4	0	0	4
Pre-requisites/Exposure	Basic Nuclear and Particle Physics				
Co-requisites					

Course Objectives

1. To acquire the knowledge of deuteron problem and nuclear forces.
2. To have an insight about various accelerators and detectors of nuclear particles.
3. To acquire knowledge of various nuclear electronic instruments.
4. To have an insight of production and properties of various elementary particles.

Course Outcomes

On completion of this course, the students will be able to:

CO1. Better understand the basic requirements of deuteron properties and neutron-proton interactions.

CO2. Understand various types of advance accelerators and detectors developed.

CO3. Knowledge of various electronic instruments used to study nuclear particles and nuclear reactions.

CO4. Deeper understanding of different types of elementary particles, their properties and interactions.

Catalog Description

This course is intended to cover the advancements of nuclear and particle physics. This course gives the theoretical explanations as well as the practical justifications of various concepts related to nucleons and their interactions. It discusses different accelerators and detectors used for the detection and acceleration of elementary particles. This course covers the interactions of elementary particles and instruments required to study the interactions.

Course Content

UNIT-I Two Nucleon systems & Nuclear Forces: 15 Lectures

Deuteron: ground state, wave equations and its solution, excited states, radius calculation using wave equation; Low energy Neutron-proton scattering; Scattering length; spin dependence of n-p interaction; Effective Range Theory.

UNIT-II 15 Lectures

Accelerators and Detectors of Nuclear Particles

Accelerators: Accelerators and their classification, ion sources, Electrostatic accelerators, Cockroft-Walton generator, Van de Graff accelerators, cyclotron, synchro- cyclotron, Principles of phase stability, betatron, betatron oscillations, electron synchrotron, Microtron, sector focused cyclotron, proton synchrotron (bevatron), Alternating gradient focusing, storage rings, linear accelerators.

UNIT-III 15 Lectures

Nuclear radiation detection:

Methods for the detection of free charge carriers, ionization chamber, proportional and Geiger-Muller counters, solid-state detectors, Methods based on light sensing, Scintillation detectors, Cherenkov detector, Methods of visualization of tracks of radiation, Wilson cloud chamber, bubble chamber, spark chamber, Nuclear Emulsion techniques, solid state nuclear track detectors,

Nuclear electronics
Pulse shaping, Pulse amplifiers, voltage discriminators, Pulse height analyzer, Counters: Binary and decade scalers.

UNIT-IV

Elementary Particles **15 Lectures**
Kinematics of high energy collisions, Production and properties of pi-mesons, Neutral pi-meson, Muons and their properties, K-mesons and hyperons, fundamental interactions in nature, classification of elementary particles, conservation laws, Anti-nucleons, Intrinsic Parity of the Pions, Resonance Particles, Symmetry Classification of Elementary Particles, Quark Hypothesis, Quantum Chromodynamics, Charmed Quark, Beauty and Truth, Weak Interactions, Unification of Weak and Electromagnetic Interactions.

Textbooks:
- Nuclear Physics by S N Ghoshal, First edition, S. Chand Publication, 2010.

Reference book(s):

- Basic ideas and concepts in Nuclear Physics: An introductory approach by K Heyde, third edition, IOP Publication, 1999.
- Introductory Nuclear Physics by K S Krane, Wiley-India Publication, 2008.
- Nuclear Physics: principles and applications by J Lilley, Wiley Publication, 2006.
- Radiation detection and measurement, G F Knoll, John Wiley & Sons, 2010.
- Introduction to elementary particles by D J Griffiths, Wiley, 2008.

BSMA711A	**ADVANCED MATLAB PROGRAMMING**	L	T	P	C
Version 1.0		2	0	0	2
Pre-requisites/Exposure	Basic MATLAB				
Co-requisites	MATLAB software				

Course Objectives

1. Understanding the large-scale data by conduct experiments, as well as to analyse and interpret data.

2. Introduced and identify, formulate, and solve engineering problems, function on multidisciplinary teams.

3. Understanding of professional and ethical responsibility.

4. Recognition of the need for, and an ability to engage in life-long learning.

5. Understand the design of a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

Course Outcomes

On completion of this course, the students will be able to

CO1. Applied the knowledge and understanding to design and conduct experiments, as well as to analyse and interpret data.
CO2. Applied the concept of different type of function in multidisciplinary area.
CO3. Able to identify, formulate, and solve engineering problems.
CO4. Recognize and determined of professional and ethical responsibility.
CO5. Recognition of the need for, and an ability to engage in life-long learning.
CO6. An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

Catalog Description

The course is aimed for participants working or conducting research in scientific computing. Covered topics in scientific computing will include numerical linear algebra, numerical optimization, ODEs, and PDEs. Participants will be introduced to advanced MATLAB features, syntaxes, and toolboxes not traditionally found in introductory courses. Material will be reinforced with in-lecture examples, demos, and homework assignment involving topics from scientific computing. MATLAB topics will be drawn from: advanced graphics (2D/3D plotting, graphics handles, publication quality graphics, animation), MATLAB tools (debugger, profiler), code optimization (vectorization, memory management), object-oriented programming, compiled MATLAB (MEX files and MATLAB coder), interfacing with external programs, toolboxes (optimization, parallel computing, symbolic math, PDEs). In exact, students learn how to apply the tools of calculus to a variety of problem situations.

Course Content

UNIT I **10 Lectures**

Introduction to MATLAB: Starting and ending MATLAB session, MATLAB environment, MATLAB help, types of files, search path, some useful MATLAB commands, data types, constant and variables, Arithmetic, Relational and Logical Operators, built-in functions, Import and export of data, Working with files and directories.

UNIT II **10 Lectures**

MATLAB Programming: Function files, sub functions, global variations, loops, branches and control flow.

MATLAB Graphics: Two-dimensional plots, multiple plots, style options, legend command, subplots, three-dimensional plots, Mesh and surface plots.

UNIT III **05 Lectures**

Advanced Functions: Differentiation, Integration, Double integration, First and second order ODE, Publishing a report.

UNIT IV **05 Lectures**

Symbolic Processing With MATLAB: Symbolic Expressions and Algebra, Algebraic and Transcendental Equations, Calculus, Symbolic Linear Algebra, ordinary and partial differential equation, Symbolic Tutors.

Reference Books/Materials

- L.F. Shampine, I Gladwell, S. Thompson; Solving ODE’s with MATLAB, Cambridge University Press.
- Rudra Pratap; Getting Started with MATLAB 7, Oxford Press.
- S.R. Otto and J.P. Denier, An Introduction to Programming and Numerical Methods in MATLAB, Springer.
- Won Young Yang, Tae-Sang-Chung, John Morris; Applied numerical Methods using MATLAB, John Wiley and Sons.

BSMA771A	**ADVANCED MATLAB PROGRAMMING LAB**	L	T	P	C
Version 1.0		0	0	2	1
Pre-requisites/Exposure	Basic MATLAB				
Co-requisites	MATLAB software				

Course Objectives

1. Understanding the large-scale data by conduct experiments, as well as to analyse and interpret data.

2. Introduced and identify, formulate, and solve engineering problems, function on multidisciplinary teams

3. Understanding of professional and ethical responsibility.

4. Recognition of the need for, and an ability to engage in life-long learning.

5. Understand the design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

Course Outcomes

On completion of this course, the students will be able to

CO1. Test program output for accuracy using hand calculations and plotting the different type of the graphs.

CO2. Analyses, the applicability and accuracy of matrix numerical solutions to linear systems of equations.

CO3. Analyses and applied the matrix method for finding the higher power of the matrix.

CO4. Demonstrate understanding of common numerical programing for finding the solution of Laplace and Wave equations

CO5. Write efficient, well-documented MATLAB code and present numerical results in an informative way of different real-life problems.

Catalog Description

The course is aimed for working or experiential coding or conducting research in scientific computing. Covered topics in scientific computing will include numerical linear algebra, numerical optimization, ODEs, and PDEs. Participants will be introduced to advanced MATLAB features, syntaxes, and toolboxes not traditionally found in introductory courses. Material will be reinforced with in-lecture examples, demos, and homework assignment involving topics from scientific computing. MATLAB topics will be drawn from: advanced graphics (2D/3D plotting, graphics handles, publication quality graphics, animation), MATLAB tools (debugger, profiler), code optimization (vectorization, memory management), object-oriented programming, compiled MATLAB (MEX files and MATLAB coder), interfacing with external programs, toolboxes (optimization, parallel computing, symbolic math, PDEs). In exact, students learn how to apply the tools of calculus to a variety of problem situations.

Course Content

1. Compute the sum of n integers.
2. Find the factorial of n numbers.
3. Plot the graph of any function.
4. Solutions of simultaneous linear equations.
5. Solution of algebraic / transcendental equations.
6. To find the largest Eigen value of a matrix using power-method.
7. Inversion of matrices
8. Numerical differentiation
9. Numerical integration
10. Solution of ordinary differential equations
11. Statistical problems on central tendency and dispersion
12. Fitting of curves by least square method.
13. To find the numerical solution of Laplace equation.
14. To find the numerical solution of Wave equation

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

Reference Books/Materials

- Rudra Pratap; Getting Started with MATLAB 7, Oxford Press.
- S.R. Otto and J.P. Denier, An Introduction to Programming and Numerical Methods in MATLAB, Springer.
- Won Young Yang, Tae-Sang-Chung, John Morris; Applied numerical Methods using MATLAB, John Wiley and Sons.

II-SEMESTER

BSPH702A	MATHEMATICAL METHODS OF PHYSICS-II	L	T	P	C
Version 2.0		4	0	0	4
Pre-requisites/Exposure	Calculus				
Co-requisites	Mathematical Physics-I				

Course Objectives

1. To make them learn about the Fourier series expansion and its applications.

2. To enable them to use theory of errors on various types of data.

3. To give knowledge of special Functions such as Legendre, Bessel, Hermite and Laguerre and their properties.

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

Course Outcomes

On completion of this course, the students will be able to

CO1. Apply Fourier series expansion in solving problems of interest to physicists.
CO2. Better understand data interpretation and error analysis.
CO3. Understand use of special functions such as Legendre, Bessel, Hermite and Laguerre.
CO4. Solve partial differential equations encountered in Physics and Engineering.

Catalog Description

This course aims to demonstrate the use of mathematical techniques in solving problems in Physics and to provide a deeper understanding of the mathematics underpinning theoretical physics. The course is intended to develop the theory of errors, Fourier series, special functions and partial differential equations. Emphasis will be on illustrative examples from Physics and Engineering.

Course Content

UNIT-I **15 Lectures**

Fourier series: Dirichlet's conditions for a Fourier series; Advantages of Fourier series; Determination of Fourier coefficients (Euler's Formulae); Fourier Series for discontinuous functions.

Fourier Integral Theorem; Fourier sine and cosine integrals; Fourier’s complex integral; Fourier transforms; Fourier sine and cosine transforms; Properties of Fourier transforms; Convolution.

UNIT-II **15 Lectures**

Laplace transforms; Properties of Laplace transform. First shifting theorem; Laplace transform of unit function; Second shifting theorem; Convolution theorem.

Partial differential equations; Method of Forming Partial Differential Equations; Solution of equation by Direct Integration.

UNIT-III **15 Lectures**

Orthogonal curvilinear coordinates, differential of arc length, geometrical significance of h1 and h2, differential operator, curl, divergence, Laplacian operator, curvilinear and spherical coordinates polar co-ordinates; Relation between cylindrical and spherical co-ordinates.

UNIT-IV **15 Lectures**

Elementary probability theory; Addition law of probability; multiplication law of probability random variables, Binomial distribution, Poisson and normal distributions. Central limit theorem.

- Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris, 2013, 7th Edn., Elsevier.
- An introduction to ordinary differential equations, E.A. Coddington, 2009, PHI learning
- Differential Equations, George F. Simmons, 2007, McGraw Hill.
- Mathematical Tools for Physics, James Nearing, 2010, Dover Publications.
- Mathematical methods for Scientists and Engineers, D.A. McQuarrie, 2003, Viva Book

- Advanced Engineering Mathematics, D.G. Zill and W.S. Wright, 5 Ed., 2012, Jones and Bartlett Learning
- Mathematical Physics, Goswami, 1st edition, Cengage Learning
- Engineering Mathematics, S.Pal and S.C. Bhunia, 2015, Oxford University Press
- Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.
- Essential Mathematical Methods, K.F.Riley & M.P.Hobson, 2011, Cambridge Univ. Press.
- Mathematical Physics, H.K. Dass and R. Verma, S. Chand & Company.

BSPH704A	**ELECTRONICS-II**	L	T	P	C
Version 2.0		4	0	0	4
Pre-requisites/Exposure	Digital Electronics				
Co-requisites					

Course Objectives

1. To acquire knowledge of Analog and Digital System
2. Better understanding Flip flops,registers and counters
3. Better understanding of Microprocessor and its working
4. Understanding of Semiconductor memories.

On completion of this course, the students will be able to

CO1. Understanding the difference between Analog and Digital System and conversion from one system to another.
CO2. Better understanding of registers and counters. How they are beneficial in day-to-day life.
CO3. Provide knowledge about how microprocessors are useful in daily life applications.
CO4. Better understanding of semiconductor memories like RAM, ROM, static RAM, Dynamic RAM, PROM, EPROM.

This course is intended to cover most of the basic topics of digital electronics including Number systems, Logic gates and logic families, Boolean Algebra and Simplification, Arithmetic circuits, Data Processing Circuits, various Flip-flops, Clocks and Timers and Shift registers & counters, Microprocessor 8085, Semiconductor memories (RAM, ROM, static RAM, Dynamic RAM, PROM, EPROM).This course gives the circuit knowledge to students and students will be even able start their startups. Course will also beneficial for students in day-to-day life.

Course content

UNIT-I **15 Lectures**

Difference between analog and digital system, Ato D converter, Dto A converter, combinational circuits, comparator, Gray to Binary, Binary to gray converter.

UNIT-II **15 Lectures**

Sequential circuits: Flip Flops (R S flip flop,JK flip flop, T flip flop, D flip flop), edge triggering, level triggering. Asynchronous inputs (PRESET and CLEAR), racing condition, Master-slave flip flop, Sequential circuits, registers(shift registers), timers and counters (asynchronous and synchronous counter, ring counter, Johnson counter).

UNIT-III **15 Lectures**

Microprocessor 8085: Introduction, Basic Architecture, working, pin diagram Addressing modes and programming.

UNIT-IV **15 Lectures**

Semiconductor memories (RAM, ROM, static RAM, Dynamic RAM, PROM, EPROM).

Text Books

- Malvino and Leech, Digital Principles and Application, 4th edition, Tata McGraw Hill, New Delhi.
- Millman and Halkias, Integrated Electronics, International edition, McGraw Hill, New Delhi.
- Thomas L. Floyd, Digital Fundamentals (Universal Book Stall, India).

BSPH752A	**ELECTRONICS LAB-II**	L	T	P	C
Version 1.0		0	0	4	2
Pre-requisites/Exposure	Digital Electronics				
Co-requisites					

Course Objectives

1. To acquire knowledge of Analog and Digital System
2. Better understanding Flip flops,registers and counters
3. Better understanding of Microprocessor and its working
4. Understanding of Semiconductor memories.

Course Outcomes

On completion of this course, the students will be able to

CO1. Understanding the difference between Analog and Digital System and conversion from one system to another.
CO2. Experimental understanding of registers and counters. How they are beneficial in day-to- day life.
CO3. Provide knowledge about microprocessor programming.
CO4. Better understanding of semiconductor memories like RAM, ROM, static RAM, Dynamic RAM, PROM, EPROM.

Catalog Description

This course is intended to cover most of the basic topics of digital electronics including Number systems, Logic gates and logic families,Boolean Algebra and Simplification, Arithmetic circuits, Data Processing Circuits, various Flip-flops, Clocks And Timers and Shift registers & counters, Microprocessor 8085, Semiconductor memories (RAM, ROM, static RAM, Dynamic RAM, PROM, EPROM).This course gives the circuit knowledge to students and students will be even able start their startups. Course will also beneficial for students in day-to-day life.

Course Content

List of Experiments:

1. Study of A to D converter, D to A converter
2. Study of Combinational circuits: such as Adder, Subtractor
3. Study of BCD to seven segment converter, parity checker, magnitude comparator
4. Study of Gray to Binary, Binary to gray converter.
5. Study of Sequential circuits: Flip Flops (R S flip flop, JK flip flop, T flip flop, D flip flop)
6. Study of Master-slave flip flop, Sequential circuits, registers(shift registers)
7. Study of timers and counters (asynchronous and synchronouscounter, ring counter, Johnson counter).
8. Study of Microprocessor 8085: Introduction, Basic Architecture, working, pin diagram Addressing modes and programming.
9. Study of Semiconductor memories (RAM, ROM, static RAM, Dynamic RAM, PROM, EPROM)

BSPH706A	CLASSICAL MECHANICS II	L	T	P	C
Version 2.0		4	0	0	4
Pre-requisites/Exposure	Basic calculus skills				
Co-requisites					

Course Objectives

1. To understand the concept of motion under central force.
2. To comprehend the features of Hamilton-Jacobi Theory and Action-Angle Variables
3. To acquire the knowledge of rigid body motion
4. To gain the insight of small oscillations

On completion of this course, the students will be able to

CO1. The students will be able to understand the physics behind stability of orbits and Kepler's problem.
CO2. Enable students to know the significance of Hamilton-Jacobi Theory and Action- Angle Variables.
CO3. Explain the concept of rigid body motion and different vectors involved in it.
CO4. Understand the method of writing normal modes using eigen value equation.

This course imparts the understanding of main aspects of the inadequacies of classical mechanics and insight of concepts of motion under central force. It assesses the application of Hamilton Jacobi theory using action angle variables as well as rigid body motion and equations for the detailed study of problem of small oscillations.

Course Content

UNIT-I **15 Lectures**

Motion under Central force: Reduction to the equivalent one-body problem, general features of central force motion, equation of the orbit its features, Stability of orbits and conditions for closure, The Kepler's Problem: Motion under inverse square force, thevirial theorem, Scattering in a Central Force Field, Transformation of the Scattering Problem to Laboratory Coordinates.

UNIT-II **15 Lectures**

Hamilton-Jacobi Theory and Action-Angle Variables: The Hamilton-Jacobi Equation for Hamilton's principal function, The Harmonic Oscillator Problem as an example of the Hamilton-Jacobi Method, The Hamilton-Jacobi equation for Hamilton's characteristic function, Action angle variables for systems with one degree of freedom,

UNIT-III **15 Lectures**

Rigid Body Motion: Independent co-ordinates of rigid body, orthogonal transformations, Eulerian Angles and Euler's theorem, infinitesimal rotation, Rate of change of a vector, angular momentum and kinetic energy of a rigid body, the inertia tensor, principal axis transformation, Euler equations of motion, Torque free motion of rigid body, motion of a symmetrical top.

UNIT-IV **15 Lectures**

Small Oscillations: Eigen value equation, Free vibrations, Normal Coordinates, Vibrations of a triatomic molecule.

Textbooks

- Classical Mechanics, Gupta, Kumar and Sharma.

Reference Books/Materials

- Classical Mechanics, H. Goldstein, C. P. Poole, J. L. Safko, 3/e, 2002, Pearson Education.
- Classical Mechanics, John R. Taylor, 2005, University Science Books.
- Classical Mechanics, Tai L. Chow, 2013, CRC Press.
- Classical Mechanics, R. Douglas Gregory, 2015, Cambridge University Press.
- An Introduction to Fluid Dynamics, G. K. Batchelor, Cambridge University Press, 2002.

BSPH708A	ADVANCED SOLIDSTATE PHYSICS-I	L	T	P	C
Version 1.0		4	0	0	4
Pre-requisites/Exposure	Solid State Physics				
Co-requisites					

Course Objectives

1. Learn the basics of crystal structure.
2. Develop an understanding of X-ray diffraction patterns and accurate finding of crystal structure of materials.
3. Understanding the source of magnetic behavior of the materials.
4. Types of magnetism and their applications.

Course Outcomes

On completion of this course, the students will be able to:

CO1. Better understanding of atomic arrangement inside the materials. and the factors which may influence the arrangement.

CO2. Comprehend the functioning of X ray diffractometer and gaining knowledge about crystal structure prediction.

CO3. Deep insight about the magnetic behavior and its origin.

CO4. Enhanced knowledge about the correlation between crystal structure and physical properties of materials which may useful to synthesize new materials.

Catalog Description

This course imparts the basic knowledge of construction of materials, microscopically. The course deals with the factors and conditions which are required to determine the crystal structure. The microstructure and physical properties are correlated, so dealing with the magnetic properties of the materials. The course further delivers a keen understanding of magnetism and its application in technology.

Course Content

UNIT-I **15 Lectures**

Crystal Structure: Lattice and basis, primitive and non-primitive cells, seven crystal system, crystal symmetry,Point groups, centrosymmetric and non- centrosymmetric point groups; Space groups; Packing fraction: SC, BCC, FCC and HCP; directions, planes and Miller indices; inter planer spacing; allotropy and polymorphism;

UNIT-II **15 Lectures**

Defects in crystal: Thermal, point, line, surface and volume defects; Reciprocal Lattice, Bragg`s law and reciprocal lattice.

X-Ray Diffraction Bragg`s law, X-ray spectroscopy, Diffraction directions, Diffraction methods, Diffraction under nonideal conditions;

UNIT-III **15 Lectures**

Intensities of Diffracted Beams: Scattering by an electron, Scattering by an atom, Scattering by a unit cell; Structure-factor calculations, Multiplicity factor, Lorentz factor, Absorption factor, temperature, Intensities of powder pattern lines

UNIT-IV **15 Lectures**

Diamagnetism and Paramagnetism: Magnetic Moments of Electrons, Magnetic Moments of Atoms, Theory of Diamagnetism, Diamagnetic Substances, Classical Theory of Paramagnetism, Quantum Theory of Paramagnetism, Gyromagnetic Effect, Magnetic Resonance, Paramagnetic Substances: Salts of the Transition Elements, Salts and Oxides of the Rare Earths, Rare-Earth Elements, Metals, Ferromagnetism, Antiferro-magnetism, Ferrimagnetism

Text book:

- Solid State Physics, S.O.Pillai, New Age Publication
- Elements of X-Ray Diffraction, B.D. Cullity. Addison-Wesley Publishing Company,
- Introduction to Magnetic Materials (2ndEdition,), B.D. Cullity and C.D. Graham, Wiley (2009)

References Books:

- Introduction to Solid State Physics, Charles Kittel, 8th Ed., 2004, Wiley India Pvt. Ltd.
- Elements of SolidState Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice-Hall of India.
- Introduction to Solids, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill.
- Solid State Physics, N.W. Ashcroft and N.D. Mermin, 1976, Cengage Learning.
- Solid-state Physics, H. Ibach and H. Luth, 2009, Springer. Reference Books/Materials

BSPH754A	**ADVANCED SOLID STATE PHYSICS Lab-I**	L	T	P	C
Version 1.0		0	0	4	2
Pre-requisites/Exposure	Solid State Physics				
Co-requisites					

Course Objectives

1. Learn the basics of crystal structure.
2. Develop an understanding of X-ray diffraction patterns and accurate finding of crystal structure of materials.
3. Understanding the source of magnetic behavior of the materials and experimental verification.
4. Experiments related to magnetism.

Course Outcomes

On completion of this course, the students will be able to:

CO1. Better understanding of atomic arrangement inside the materials. and the factors which may influence the arrangement.
CO2. Comprehend the X-ray diffraction data analysis crystal structure prediction.
CO3. Deep insight about the magnetic behavior and its source through experiments.
CO4. Enhanced experimental knowledge about the correlation between crystal structure and physical properties of materials which may useful to synthesize new materials.

Catalog Description

This course imparts the basic knowledge of construction of materials, microscopically. The course deals with the factors and conditions which are required to determine the crystal structure. The microstructure and physical properties are correlated, so dealing with the magnetic properties of the materials. The course further delivers keen understanding of magnetism and its application in technology.

Course Content

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1. To Study the structure of Simple cubic crystal system.
2. To Study the structure of Body centered cubic crystal system
3. To Study the structure of Face centered cubic crystal system
4. To Study the structure of tetragonal crystal system
5. To Study the structure of Orthorhombic crystal system
6. To Study the structure of Rhombohedral crystal system
7. To Study the structure of Hexagonal crystal system
8. To Study the structure of monoclinic Crystal system
9. To Study the structure of Triclinic crystal system
10. To Study the structure of Perovskites

TEXTBOOKS

- Solid State Physics, S.O.Pillai, New Age Publication
- Elements of X-Ray Diffraction, B.D. Cullity. Addison-Wesley Publishing Company,
- Introduction to Magnetic Materials (2ndEdition,), B.D. Cullity and C.D. Graham, Wiley(2009)

References Books:

- Introduction to Solid State Physics, Charles Kittel, 8th Ed., 2004, Wiley India Pvt. Ltd.
- Elements of Solid State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice-Hall of India.
- Introduction to Solids, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill.
- Solid State Physics, N.W. Ashcroft and N.D. Mermin, 1976, Cengage Learning.
- Solid-state Physics, H. Ibach and H. Luth, 2009, Springer. Reference Books/Materials

BSMA776A	LATEX LAB	L	T	P	C
Version 1.0		0	0	2	1
Pre-requisites/Exposure					
Co-requisites					

Course Objectives

1. Learn to prepare a publishable document.
2. Understanding the typesetting system LaTeX.
3. Enhance computational and technical skills.
4. Understanding the typesetting of a book through LaTeX.

Course Outcomes

On completion of this course, the students will be able to:

CO1. Learn a typesetting system that handles complex mathematical expressions.
CO2. Understand utility of different document such as article, book and beamer.
CO3. Analyze how different packages provide additional typesetting characteristics.
CO4. Write almost every form of publishing document ranging from small, medium or large to scientific.

Catalog Description

This course imparts the basic concepts of Latex Lab. It enables them to type mathematical document and research paper. This course helps students in variety of ways to upload their own figures and tables in document. The course introduces the basic concepts about packages, commands and formatting of documents.

Course Content

Introduction to TeX and LaTeX, Type-setting a simple document, Adding basic information to a document, Environments, Footnotes, Sectioning and displayed material

Accents and symbols, Mathematical typesetting (elementary and advanced): Subscript/ Superscript, Fractions, Roots, Ellipsis, Mathematical Symbols, Arrays, Delimiters, Multiline formulas, Spacing and changing style in math mode.

Graphics in LaTeX, Simple pictures using PSTricks, Plotting of functions, Beamer presentation.

Textbooks

- Bindner, Donald & Erickson, Martin. (2011). A Student's Guide to the Study, Practice, and Tools of Modern Mathematics. CRC Press, Taylor & Francis Group, LLC.
- Lamport, Leslie (1994). LaTeX: A Document Preparation System, User's Guide and Reference Manual (2nd ed.). Pearson Education. Indian Reprint.

III-SEMESTER

BSPH801A	ATOMIC AND MOLECULAR PHYSICS-I	L	T	P	C
Version 1.0		4	0	0	4
Pre-requisites/Exposure	Basic knowledge of atomic structure				
Co-requisites					

Course Objectives

1. To understand the fundamentals of different atomic models and introduction of vector atom model.
2. To comprehend the features of Pauli Principle and shell structure
3. To acquire the knowledge of general features and doublet nature of alkali like spectra.
4. To gain the insight of the concept of spin and qualitative description of coupling schemes as well as the detailed theory of X-ray spectra.

Course Outcomes

On completion of this course, the students will be able to
CO1. The students will be able to learn the physics behind the evolution of different atomic models, energy levels, spectral series of Hydrogen and discovery of Deuterium.
CO2. Enable students to recall Pauli principle and the description of Fermions, Bosons in terms of wave functions.
CO3. Understand the Alkali spectra and its features.
CO4. Gain knowledge of the spin concept, coupling schemes and X- ray production mechanism and spectra.

Catalog Description

This course imparts the understanding of atomic models and explanation of spectra of Hydrogen like atoms, implementation of quantum concepts and spin orbit interaction for analysis of fine structure of Hydrogen spectral lines. It assesses the concept of Pauli Exclusion Principle to study the spectra of multielectron atoms. Further, it introduces the broad features of Alkali spectra and its explanation along with the qualitative description of Zeeman effect, Paschen –Back effect and Stark effect. In addition to this, there is a detailed description of X-ray production and its spectral types.

Course Content

UNIT-I **15 Lectures**

Atom Models: Rutherford scattering experiment and the nuclear model of the atom, size of thenucleus, Bohr model of the atom: energy levels and spectral series.

Hydrogen and Hydrogen-like ions: Series in hydrogen, circular motion, nuclear mass effect, elliptical orbits, energy levels. Fine structure: basic facts and Sommerfeld theory, electron spin and spin-orbit coupling, relativistic correction and Lamb shift (qualitative), correspondence principle, discovery of deuterium, positronium and muonic atom energy levels compared to hydrogen energy levels, Franck-Hertz experiment.

UNIT-II **15 Lectures**

Quantum (Vector) model of the hydrogen atom (no derivation) and quantum numbers, principal quantum number, orbital quantum number, magnetic quantum number, probabilistic electronic orbits (radial and angular), radiative transitions, selection rules.

Pauli's principle and shell structure: Systems with several electrons and spin functions. Symmetric and anti-symmetric wave functions, bosons and fermions, atomic shells and subshells.

UNIT-III **15 Lectures**

Alkali-like Spectra: General features, doublet structure, Larmor's theorem and magnetic levels, elementary theory of weak and strong magnetic fields, Zeeman effect in doublet spectra: anomalous Zeeman effect and the anomalous g-value, Paschen-Back effect, Stark effect(qualitative idea).

UNIT-IV **15 Lectures**

Complex Spectra: Bohr magneton, spin of the electron, spin angular momentum, magnetic dipole moments due to orbital motion and spin of the electron, Stern-Gerlach experiment, LS-Coupling scheme, normal triplets, basic assumptions of the theory, identification of terms, selection rules, jj-coupling (Qualitative). X-rays: production, Laue's experiment, Bragg's law, X-ray spectra: continuous and characteristic spectra, X-ray emission spectra and Moseley law and X-ray series, Auger effect, X-ray absorption spectra and structure of absorption edges.

Textbooks

- Atomic & Molecular Physics, Raj Kumar.

Reference Books/Materials

- Atomic, Molecular, Laser and Nuclear Physics, Dr. V.P. Seth, Dr. Nawal Kishore, Vijaya Publications.
- Modern Physics, A.K. Sikri.
- Modern Physics, Arthur Beiser

BSPH803A	**ADVANCED QUANTUM MECHANICS-I**	L	T	P	C
Version 1.0		4	0	0	4
Pre-requisites/Exposure	Quantum Mechanics				
Co-requisites	Mathematical Physics				

Course Objectives

1. Acquire knowledge of Schrödinger’s equation for spherically symmetric potentials, three dimensional cases.
2. Know about Hilbert space, operators as matrix; matrix form of a wave function, unitary transformation, change of basis; eigen value problem, and Schrödinger, Heisenberg and interaction matrix representation.
3. Explain physical meaning of identity, Symmetric and anti-symmetric wave functions, Exchange degeneracy, Particle exchange operator, Distinguishability of identical particles, the Pauli`s exclusion principle and collision of identical particles.
4. Know about orbital angular momentum and total angular momentum operator and its commutation relations.

Course Outcomes

On completion of this course, the students will be able to:

CO1. Better understanding of 3D quantum mechanical systems and their co relation with the real physical world.

CO2. Use operator techniques to solve relevant problems.

CO3. Comprehend the concepts of electronic spin and importance of spin to describe material behavior.

CO4. Gain deeper understanding of angular momentum. Learn how coupling of angular momentum and spin takes place and their applications in various physical systems.

Catalog Description

This course is intended to cover most of the basic topics in quantum mechanics, including postulates, three-dimensional spherically symmetric potentials systems, angular momentum, operator methods, harmonic oscillators, hydrogen etc. This course gives the theoretical explanations of experimental data and enhanced the analytical concepts.

Course Content

UNIT-I **15 Lectures**

Spherically Symmetric Systems: Schrödinger's equation for spherically symmetric potentials; three-dimensional harmonic oscillator (spherically symmetric case); the rigid rotator with free axis; the rigid rotator in plane; Hydrogen atom: solutions of ϕ; θ and r equations; recursion formula; energy values; degeneracy; the normal states of hydrogen atoms, multi-electron systems and periodic table.

UNIT-II **15 Lectures**

Elementary representation theory: Introduction; Hilbert space; operators as matrix; matrix form of a wave function; unitary transformation: change of basis; eigen value problem; Schrödinger, Heisenberg and interaction matrix representation; equation of motion in matrix form; Dirac's Bra and Ket notations; Matrix theory of harmonic oscillator; raising and lowering operators.

UNIT-III **15 Lectures**

Identical Particles and Spins: Introduction; Physical meaning of identity; Symmetric and anti-symmetric wave functions; Exchange degeneracy; Particle exchange operator; Distinguishability of identical particles; the Pauli`s exclusion principle; collision of identical particles; Spin angular momentum; electron spin hypothesis; Pauli's spin matrices for electrons; Pauli`s operators and their properties; Pauli`s eigen values and Eigen functions; density operator and density matrix; symmetric and anti-symmetric wave functions of Hydrogen Molecule.

UNIT-IV **15 Lectures**

Theory of Angular Momentum: Orbital angular momentum; Total angular momentum operator and its commutation relations; Eigen values of total angular momentum (J2), its component along z direction (Jz) and ladder operators (J+ & J-); explicit form of total angular momentum matrices; Clebsch-Gorden coefficients; addition of spin and orbital angular momentum; recursion relation of Clebsch-Gorden coefficients; electromagnetic transitions (selection rules on j and m).

Textbooks

- Introduction to Quantum Mechanics (Prentice Hall) by D. J. Griffiths
- Principles of Quantum Mechanics (2nd Ed., Kluwer Academics) by R. Shanker
- Quantum mechanics: A Modern Development (World Scientific Pub. Pvt. Ltd) by L.E. Balletine.
- Schaum's Outline of Theory and Problems of Quantum Mechanics (The McGraw-Hill Companies, Inc.) by Yoav Peleg, Reuven Pnini&ElyahuZaarur.
- Quantum Mechanics (PHI Learning Private Limited) by G. Aruldhas
- Quantum Mechanics with Basic Field Theory(Cambridge University Press) by Bipin R. Desai

Reference Books/Materials

- Quantum Mechanics (McGraw Hill Book Co, New York) by L. I. Schiff
- Quantum Mechanics (John Wiley & Sons, Inc) by E. Merzbacher

BSPH805A	ADVANCED SOLID STATE PHYSICS-II	L	T	P	C
Version 1.0		4	0	0	4
Pre-requisites/Exposure	Solid State Physics				
Co-requisites					

Course Objectives

1. Learn the basics of quantum mechanical models behind physical properties.
2. Develop an understanding of origin of semiconducting properties of materials.
3. Understanding the source of dielectric behavior of the materials.
4. Types of superconductivity and its applications.

Course Outcomes

On completion of this course, the students will be able to:

CO1. Better understanding of role of atomic behavior behind the physical properties of the materials and the factors which may influence the properties.
CO2. Comprehend the functioning of dielectric materials and gaining knowledge about the application part of the material in the field of core science and technology.
CO3. Deep insight about the semiconducting behavior and its origin.
CO4.Enhanced knowledge about the superconductors and origin/theories behind superconducting phenomenon.

Catalog Description

This course imparts the basic knowledge of construction of materials, microscopically. The course deals with the physical properties, like dielectric, superconducting and semi-conducting properties, of the materials. The focus of the course is on atomic origin of properties of the materials. The course further delivers keen understanding of utilization and applications of materials in the field of science and technology.

Course Content

UNIT-I **15 Lectures**

Band theory

Bloch theorem, the Kronig-Penny Model, constriction of Brillouin zones, symmetry properties of energy function, extended, reduced and periodic zones schemes, effective mass of an electron, the nearly free electron model, conductors, semiconductors and insulators.

UNIT-II **15 Lectures**

Semiconducting properties of Materials

Semiconductors, carrier concentrations in intrinsic semiconductors, Fermi level; Statics of Extrinsic semiconductors: Fermi level, general equation for impurity semiconductor, Fermi level in an n-type semiconductor at very low temperature, Theory of n-type semiconductor, Theory of p-typesemiconductor, mobility of charge carriers, effect of temperature on mobility, electrical conductivity of semiconductors, Hall Effect, junction properties.

UNIT-III **15 Lectures**

Dielectrics

Dielectric constant, permittivity, microscopic concept of polarization, Langevin`s theory of polarization in polar dielectrics, Local fields in solids and liquids, Classius-Mosotti relation, Static Dielectric constant in solids and liquids, Ferroelectricity, Piezoelectricity, dielectrics in AC fields, Ionic polarizability as a function of frequency, Complex dielectric constant of non-polar solids, Dipolar relaxation, dielectric losses,

UNIT-IV **15 Lectures**

Superconductivity

Mechanism of superconductors, Effect of magnetic field, AC resistivity, Critical currents, Meissner Effect, Thermal properties, energy gap, Isotope effect, Mechanical effects, penetration depth, Type-I and Type-II superconductors, London equations, Superconductors in AC fields, Thermodynamics of superconductors, BCS theory, Quantum tunnelling, Josephson`s tunnelling, DC Josephson`s effect, Applications of superconductors.

Textbook:

- Solid State Physics, S.O.Pillai, New Age Publication
- Elements of X-Ray Diffraction, B.D. Cullity. Addison-Wesley Publishing Company,
- Introduction to Magnetic Materials (2ndEdition,), B.D. Cullity and C.D. Graham, Wiley(2009)

References Books:

- Introduction to Solid State Physics, Charles Kittel, 8th Ed., 2004, Wiley India Pvt. Ltd.
- Elements of Solid State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice-Hall of India.
- Introduction to Solids, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill.
- Solid State Physics, N.W. Ashcroft and N.D. Mermin, 1976, Cengage Learning.
- Solid-state Physics, H. Ibach and H. Luth, 2009, Springer. Reference Books/Materials

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BSPH851A	**ADVANCED SOLIDSTATE PHYSICS-II LAB**	L	T	P	C
Version 1.0		0	0	4	2
Pre-requisites/Exposure	Solid State Physics				
Co-requisites					

Course Objectives

1. The objective of the laboratory is learning through hands on experiment.
2. Develop an understanding of origin of semiconducting properties of materials.
3. Understanding the source of dielectric behavior of the materials and their experimental verification.
4. Applications of advanced materials.

On completion of this course, the students will be able to:

CO1. Better understanding of role of atomic behavior behind the physical properties of the materials and the factors which may influence the properties.
CO2.Comprehend the functioning of dielectric materials and gaining knowledge about the application part of the material in the field of core science and technology.
CO3. Deep insight about the semiconducting behavior and its origin.
CO4. Enhancement in knowledge about the superconductors and origin/theories behind the superconducting phenomenon.

This course imparts the basic experimental knowledge of advanced of materials. The course deals with the physical properties, like dielectric, superconducting and semi-conducting properties, of the materials. The focus of the course is experimental verification of physical properties of the materials. In addition, course bridges the theoretical knowledge and its experimental counterpart. The course further delivers keen understanding of utilization and applications of materials in the field of science technology.

Course Content

1. To find the band gap of intrinsic semi-conductor by using four probe method.
2. To determine the hysteresis loss of ferromagnetic material by using CRO.
3. To measure the dielectric constant of the material.
4. Determine the value of Hall coefficient for a given sample.
5. To study the temperature dependence of Hall coefficient of a given semiconductor.
6. Determine the Curie Temperature of a given ferroelectric material
7. Determine the specific heat of a given sample at room temperature.
8. Preparation of single crystals of copper sulfate using slow evaporation technique and identification of the c-axis of the newly grown triclinic crystal.
9. Determination of magnetoresistance of a given semiconductor for different magnetic field.

Textbook:

- Solid State Physics, S.O.PIllai, New Age Publication.
- Elements of X-Ray Diffraction, B.D. Cullity. Addison-Wesley Publishing Company.
- Introduction to Magnetic Materials (2ndEdition,), B.D. Cullity and C.D. Graham, Wiley (2009).

References Books:

- Introduction to Solid State Physics, Charles Kittel, 8th Ed., 2004, Wiley India Pvt. Ltd.
- Elements of Solid State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice-Hall of India.
- Introduction to Solids, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill.
- Solid State Physics, N.W. Ashcroft and N.D. Mermin, 1976, Cengage Learning.
- Solid-state Physics, H. Ibach and H. Luth, 2009, Springer. Reference Books/Materials.

BSPH807A	ELECTRODYNAMICS	L	T	P	C
Version 2.0		4	0	0	4
Pre-requisites/Exposure					
Co-requisites					

Course Objectives

1. To make them learn about the special techniques used in mathematical physics.
2. To enable them to use Laplace equation and electro-dynamical theory.
3. To give knowledge of electromagnetic waves, potential and fields.
4. To impart knowledge about radiation, electrodynamics and relativity.

Course Outcomes

On completion of this course, the students will be able to:

CO1. Apply concepts of mathematical physics in solving problems of interest to physicists.

CO2. Better understand Laplace equation, electro-dynamical theory and its applications.

CO3. Understand use of electromagnetic waves, potential and fields.

CO4. Solve equations encountered in Physics and Engineering.

Catalog Description

This course aims to demonstrate the use of mathematical techniques in solving problems in Physics and to provide a deeper understanding of the electrodynamics underpinning theoretical physics. The course is intended to develop the concepts of Laplace equation and electro-dynamical theory and its applications. Emphasis will be on illustrative examples from Physics and Engineering.

Course Content

UNIT-I **15 Lectures**

Special Techniques: Vector Algebra: vector operations, component form, scalar and vector product, double and triple product, vector transformation; Differential calculus: ordinary derivative, the del operator, gradient, divergence and curl, product rule and second derivatives; Integral Calculus: line, surface and volume integrals, fundamental theorems of gradients, divergences and curls; Curvilinear co-ordinates: spherical and cylindrical coordinates; The Dirac Delta function (1-D and 3-D forms); The theory of vector fields: The Helmholtz theorem.

UNIT-II **15 Lectures**

Laplace`s equations (1-D,2-D and 3-D forms), boundary conditions and uniqueness theorems, The method of images: classic image problem, induced surface charge, force and energy; Separation of variables(Cartesian and spherical coordinates); Multipole expansion: approximate potential at large distances, the monopole and dipole terms, the electric field of a dipole.

Electrodynamical Theory: Ohm`s Law, electromotive force, motional emf, Faraday`s law, induced electric field, inductance, energy in magnetic field, Maxwell`s Equations and their significance, magnetic charge, Maxwell`s Equations in matter.

UNIT-III **15 Lectures**

Electromagnetic Waves: Waves in 1D: wave equation, boundary conditions, polarization; EM waves in vacuum: wave equation for E and B, monochromatic plane wave, energy and momentum: EMwaves in matter: propagation in linear media, reflectance and transmittance at normal and oblique incidence, absorption and dispersion: EM waves in conductors, reflection, the frequency dependenceof permittivity; guided waves: wave guides, rectangular wave guide, co axial transmission line.

Potentials and Fields: Potential formulation: scalar and vector potentials, Gauge transformations,Coulomb and Lorentz gauge; continuous distributions: retarded potentials and Jefimenko equations,point charges: Lienard-Wiechert potentials, the field of moving charge.

UNIT-IV **15 Lectures**

Radiation: Dipole radiation: electric and magnetic dipole radiation, radiation from an arbitrary source; Point charges: power radiated by a point charge, radiation reaction, physical basis of radiation reaction.

Electrodynamics and Relativity: The structure of space time, proper time and proper velocity, relativistic energy and momentum, relativistic kinematics, relativistic dynamics; Relativistic electrodynamics: magnetism as relativistic phenomenon, field transformation, field tensor, electrodynamics in tensor notation, relativistic potentials.

References Books:

- Vector analysis – Schaum's Outline, M.R. Spiegel, S. Lipschutz, D. Spellman, 2nd Edn., 2009, McGraw- Hill Education.
- Electricity and Magnetism, Edward M. Purcell, 1986, McGraw-Hill Education.
- Electricity & Magnetism, J.H. Fewkes & J.Yarwood. Vol. I, 1991, Oxford Univ.Press
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
- D.J. Griffiths, Introduction to Electrodynamics, 3rd Edn, 1998, Benjamin Cummings.

BSPH809A	**THERMODYNAMICS AND STATISTICAL PHYSICS**	L	T	P	C
Version 1.0		4	0	0	4
Pre-requisites/Exposure	Basic Thermal and Statistical Physics				
Co-requisites					

Course Objectives

1. To acquire the knowledge of Thermodynamics and Kinetic Theory of Gases.
2. To have an insight about Behavior of Real Gases.
3. To acquire knowledge of Quantum Theory of Radiation.
4. To have an insight of statistical distribution of particles and phase transitions.

Course Outcomes

On completion of this course, the students will be able to:

CO1. Better understand the laws of thermodynamics and kinetic theory of gases.

CO2. Understand behavior of real gases and the deviation from ideal behavior.

CO3. Knowledge of various laws of quantum theory of radiation and their Experimental Verification.

CO4. Deeper understanding of Bose-Einstein statistics, Fermi-Dirac statistics and phase transitions.

Catalog Description

This course is intended to cover the laws of thermodynamics and statistical physics. This course discusses in detail various phenomenon governing the behavior of gases, deviation of real gases from ideal behavior. It also gives detailed account of quantum theory of radiations, blackbody radiation, associated laws and their experimental verification. The scope of this subject also includes ensembles, statistical distribution of particles and general theory of phase transitions.

Course Content

UNIT-I **15 Lectures**

Review of Elementary Thermodynamics: Laws of thermodynamics: zeroth, first, second and third, Carnot's Engine, Carnot's theorem, Thermodynamic Potentials U, H, F and G, Maxwell's Thermodynamic Relations

Kinetic Theory of Gases: 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 Specific Heats of Gases, Mean Free Path, Collision Probability, Estimates of Mean Free Path, Transport Phenomenon in Ideal Gases: Viscosity, Thermal Conductivity and Diffusion, Brownian Motion and its Significance.

UNIT-II **15 Lectures**

Behavior of Real Gases

Deviations from the Ideal Gas Equation, The Virial Equation, Critical Constants, Continuity of Liquid and Gaseous State, Vapor and Gas, Boyle Temperature, Van der Waal's Equation of State for Real Gases, Values of Critical Constants, Law of Corresponding States, Comparison with Experimental Curves, p-V Diagrams, Joule's Experiment, Free Adiabatic Expansion of a Perfect Gas, Joule-Thomson Porous Plug Experiment, Joule-Thomson Effect for Real and Van der Waal Gases, Temperature of Inversion, Joule-Thomson Cooling,

UNIT-III **15 Lectures**

Quantum Theory of Radiation: Stefan-Boltzmann Law: Thermodynamic Proof. Radiation Pressure.

Spectral Distribution of Black Body Radiation. Wien's Distribution Law and Displacement Law. Rayleigh-Jean's Law. Ultraviolet Catastrophe. 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 and (4) Wien's Displacement Law from Planck's Law.

UNIT-IV **15 Lectures**

Review of Elementary Statistical Mechanics: B-E statistics,

Phase space, Ensembles, Probability, Bose-Einstein distribution, Fermi-Dirac statistics,

General theory of phase transitions: London theory, Nature of discontinuity of specific heat, Bose-Einstein transition, Critical exponents, Scale invariance, Critical dimensionality, Bethe approximation, Order parameter fluctuations in Gaussian approximation.

Reference book(s):

- Statistical Mechanics: R.K. Pathria and P. D. Beale(Academic Press)
- Introductory Statistical Mechanics: R. Bowley and M. Sanchez (Oxford Univ.Press)
- Statistical Physics: F. Mandl (Wiley)
- A treatise on Heat: M.N. Saha and B.N. Srivastava (Indian Press)
- Problems and Solutions on Thermodynamics andStatistical Mechanics: Lim Yung-Kou (Sarat Book House)
- Statistical Physics: Berkeley Physics Course, F. Reif, (McGraw-Hill)
- An Introduction to Statistical Physics: W.G.V. Rosser(Wiley)
- An Introduction to Thermal Physics: D. Schroeder (Pearson)
- Concepts in Thermal Physics: Blundell and Blundell (Oxford Univ. press)
- Statistical and Thermal Physics:Loknathan and Gambhir (PHI)

IV-SEMESTER

BSPH802A	ATOMIC AND MOLECULAR PHYSICS-II	L	T	P	C
Version 2.0		4	0	0	4
Pre-requisites/Exposure	Basic knowledge of Quantum Mechanics				
Co-requisites					

Course Objectives

1. To understand the concept of molecular spectra- pure rotational spectra

2. To comprehend the features of vibrational rotational spectra

3. To acquire the knowledge of Raman spectra and formation of electronic spectra

4. To gain the insight of laser, its properties and lasing phenomenon in three and four level lasers.

Course Outcomes

On completion of this course, the students will be able to:

CO1. The students will be able to recall the physics behind molecular spectra and its types

CO2. Enable students to analyze the rotational, vibrational and vibrational rotational spectra through proposed models.

CO3. Understanding the electronic spectra, Franck Condon principle and Raman effect**.**

CO4. Understand the basic lasing phenomenon, spontaneous and stimulated emission of radiation, optical pumping and population inversion. Three level and four level lasers and laser types in detail.

Catalog Description

This course imparts the understanding of main aspects of the molecular spectra and insight of central concepts of pure rotational spectra, vibrational rotational spectra-their models and determining equations. It assesses the concept of Raman spectra and provides understanding of electronic spectra in detail. In addition to this, there is detailed description of lasers and their types.

Course Content

Unit I: **15 Lectures**

Molecules and molecular spectra: The Molecular bond, electron sharing, H_2^+ molecular ion, Hydrogen molecule, complex molecules, types of molecular spectra and molecular energy states.

Pure rotational spectra: features of rotational spectra, Rigid rotator model, energy levels, spectrum
(no derivation of selection rules), non-rigid rotator.

UNIT-II **15 Lectures**

Vibrational–Rotational spectra: Features, Molecule as a Harmonic oscillator: energy levels, spectrum, Anharmonic oscillator: energy levels, Vibrational frequency, and force constants. Molecules vibrating rotator: fine structure of infrared bands.

Raman Effect: Quantum Theory of Raman Effect, Characteristics of Raman Lines, Stokes and Anti-Stokes Lines, Complimentary Character of Raman and infrared Spectra.

UNIT-III **15 Lectures**

Electronic Spectra: Features and formation of electronic spectra, electronic energy and potential curves, Vibrational Structure of Electronic band in emission and absorption spectra, Rotational Structure of Electronic bands: General relations, branches of a band, band-head formation, Intensity distribution in a vibrational band system: Franck-Condon Principle, Explanation of intensity distribution in absorption and emission bands using Franck-Condon principle. Fluorescence and Phosphorescence: Mechanism of emission.

UNIT-IV **15 Lectures**

Lasers

Interaction of radiation with matter, Einstein A and B coefficients, Metastable states, Spontaneous and Stimulated emissions, Optical Pumping and Population Inversion, Optical Resonator, Three-Level and Four-Level Lasers, Semiconductor laser, Solid state laser, liquid and gas lasers.

Textbooks

- Atomic & Molecular Physics, Raj Kumar.

Reference Books/Materials

- Atomic, Molecular, Laser and Nuclear Physics, Dr. V.P. Seth, Dr. Nawal Kishore, Vijaya Publications.
- Modern Physics, A.K. Sikri.
- Modern Physics, Arthur Beiser.

BSPH804A	**ADVANCED QUANTUM MECHANICS-II**	L	T	P	C
Version 1.0		4	0	0	4
Pre-requisites/Exposure	Quantum Mechanics				
Co-requisites	Mathematical Physics				

Course Objectives

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

On completion of this course, the students will be able to

CO1. Better understanding of perturbed quantum mechanical systems and their applications.
CO2. Formulation of time-dependent perturbed systems and their correlation between experimental phenomena.
CO3. Comprehend the concepts of quantum mechanical treatment of scattering and applications.
CO4. Gain deeper understanding of relativistic quantum mechanical systems and their reduction in nonrelativistic form.

This course is intended to cover most of the basic topics in quantum mechanics, related to perturbed systems. This course gives theoretical explanations of perturbed systems (time independent and time dependent both) and co-relates the experimental data to theoretical aspects. Here the scattering problem is tackled by quantum mechanically. Moreover, the course bridges different branches of physics, like spectroscopy, relativity etc, to quantum mechanics

Contents

UNIT-I **15 Lectures**
Approximation methods for stationary systems: Time-independent perturbation theory: (a) non-degenerate and(b) degenerate. Applications to Zeeman effect, isotopic shift and stark effect. Variational method and its applications.

UNIT-II **15 Lectures**
Approximation methods for time-dependent problems: Interaction picture. Time-dependent perturbation theory. Transition to a continuum of final states – fermi's golden rule. Application to constant and harmonic perturbations. Adiabatic and sudden approximations.

UNIT-III **15 Lectures**
Scattering: wave packet description of scattering. Formal treatment of scattering by green function method. Born approximation and applications. Partial wave analysis. Optical theorem.

UNIT-IV **15 Lectures**
Relativistic quantum mechanics: Klein-Gorden and Dirac equations. Properties of Dirac matrices. Plane wave solutions of Dirac equation. Spin and magnetic moment of electron. Nonrelativistic reduction of the Dirac equation. Spin-orbit coupling. Energy levels in a coulombs field.

Textbooks:

- Advanced Quantum Mechanics, Satya Prakesh, KedarnaathRamnaath (2016).
- Introduction to Quantum Mechanics, D.J. Griffith, Prentice Hall (1994).

Reference book(s) [RB]:

- Modern Quantum Mechanics, J.J Sakurai, Revised Edition, 1994, Addision-Wesley.
- Advanced Quantum Mechanics, B. S. Rajput, Pragati Prakashan (2004).
- Quantum Mechanics: Theory and Applications, (2019), (Extensively revised 6th Edition), Ajoy Ghatak and S. Lokanathan, Laxmi Publications, New Delhi.
- Quantum Mechanics, Eugene Merzbacher, 2004, John Wiley and Sons, Inc.
- A Text book of Quantum Mechanics, P.M.Mathews&K.Venkatesan, 2nd Ed., 2010, McGraw Hill.

BSPH806A	**NANOTECHNOLOGY**	L	T	P	C
Version 1.0		4	0	0	4
Pre-requisites/Exposure					
Co-requisites					

Course Objectives

1. To make them learn about the Electronic, electrical,Optical, mechanical and chemical properties of nanomaterials.
2. To enable them to understand importance of nanoscale materials for sensing applications.
3. To give approaches used for fabrication and characterization of nanomaterials.
4. To give approaches used for tailoring nanomaterials for a specific sensing application.

This course is set to encourage the understanding of electronic, electrical, Optical, mechanical and chemical properties of nanomaterials. This course also gives the importance of nanoscale materials for sensing applications and approaches used for fabrication and characterization of nanomaterials and gives approach used for tailoring nanomaterials for a specific sensing application. This course also gives knowledge of metallic and semiconductor nanoparticles. Nanotubes, Nanowires and Quantum Dot.

Course content

UNIT-I **15 Lectures**

This course will give thorough knowledge of the general principles of physics, chemistry and electronics that play a role on the nanometer scale and increase students' understanding of materials and their properties at the atomic and nanometer level, including an understanding of the intimate relationship between material scale (nanostructure) and the properties/functionality of materials.

UNIT-II **15 Lectures**

Students will gain insight into the materials, fabrication and other experimental techniques that can be used on the nanoscale, as well as their limitations. This course will prepare students for nanotechnology by providing them with a sound grounding in multidisciplinary areas of nanoscience and nanoengineering.

UNIT-III **15 Lectures**

Electronic, electrical,Optical, mechanical and chemical properties of nanomaterials. The importance of nanoscale materials for sensing applications. Approaches used for fabrication and characterization of nanomaterials.

UNIT-IV **15 Lectures**

Approaches used for tailoring nanomaterials for a specific sensing application. Metallic and semiconductor nanoparticles. Nanotubes, Nanowires and Quantum Dot.

Textbooks

- Nanoscale Science and Technology, R. W. Kelsall, I. W. Hamley and M. Geoghegan (John Wiley & Sons. Ltd.).
- Nano: The Essentials, T. Pradeep (Tata McGraw Hills)
- Nanostructures-Theory & Modelling by C. Delerue and M. Lannoo, Springer.
- Nanostructure by V. A. Shchukin, N. N. Ledentsov and D. Bimberg, Springer.
- Characterization of Nanophase Materials by Z. L. Wang, Wiley-VCH.
- Semiconductor Nanocrystal Quantum Dots by A. L. Rogach, Springer.
- Introduction to Nanotechnology by C. P. Poole Jr. & F. J. Owens, Wiley-Interscience.
- Nanomaterials and Nanochemistry, C. Brechignac, P. Houdy, M. Lahmani, Springer

BSPH808A	FABRICATION OF ELECTRONICS DEVICES	L	T	P	C
Version 1.0		4	0	0	4
Pre-requisites/Exposure	Basics of Electronics				
Co-requisites	Basics of Physics				

Course Objectives

1. To Identify the fabrication methods of integrated circuits such as crystal growth, diffusion, ion implantation and thin film deposition etc.
2. To Understand fundamental challenges in fabrication techniques and possible solutions.
3. To understand the fabrication process such as Lithography, metallization and CMOS technology.
4. To gain Knowledge of basic limitations of different processes and how these integrate to achievefinal device.

On completion of this course, the students will be able to
CO1. Design integrated silicon-based devices' process steps.
CO2. Understand all silicon fabrication processes, their metrologies and related theory.
CO3. Develop an understanding of the complexities involved in a complete fabrication cycle of an integrated circuit.
CO4. Gain knowledge of specifications of a clean room and other requirements of a fabrication lab.

Introduction to the basic steps and processes of fabricating integrated circuit semiconductor devices: crystal growth (thin film and bulk), thermal oxidation, dopant diffusion/implantation, thin film deposition/etching, and lithography. Introduction to process simulators, such as SUPREM. Fabrication and characterization of resistors, MOS capacitors, junction diodes and MOSFET devices.

Course Content

Unit-I **15 Lectures**

Classification of Integrated circuits (IC), Steps of IC fabrication, Basics of structure and growth of crystals, crystal growth techniques such as Czochralski method, Bridgmann technique, zone melting method etc. Cleaning of wafers, and clean room specifications.

UNIT-II **15 Lectures**

Methods of deposition of thin films such as vacuum evaporation, sputtering and chemical vapor deposition.

UNIT-III **15 Lectures**

Thermal oxidation of Silicon, diffusion, and ion implantation.

UNIT-IV **15 Lectures**

Other fabrication steps such as lithography process, metallization, contacts, CMOS fabrication, and fabrication of passive components etc.

TEXT BOOK

- Design of Analog CMOS Integrated Circuits, Behzad Razavi, 2nd Edition.
- IC Fabrication Technology, Goranga Bose, McGraw Hill Education.

BSPH810A	**LASER FUNDAMENTALS**	L	T	P	C
Version 1.0		4	0	0	4
Pre-requisites/Exposure	Optics/Quantum Mechanics				
Co-requisites					

Course Objectives

1. To familiarize the student with the fundamental characteristics of lasers.
2. To understand of the factors governing laser gain and laser output power.
3. To acquire knowledge of various pumping techniques.
4. To have an insight about laser cavity modes and different types of lasers available.

Course Outcomes

On completion of this course, the students will be able to

CO1. Better understand the basic requirements of laser action and properties of laser light.

CO2. Comprehend the concept of laser gain and optimization of laser output power.

CO3. Have an understanding of suitable pumping technique for different types of lasers.

CO4. Gain deeper understanding of different types of lasers and their applications.

Catalog Description

This course is intended to cover the fundamentals of lasers. This course gives theoretical explanations as well as the practical justifications of working principles of lasers. It discusses the requisites of lasing, factors affecting gain and output power, pumping techniques, various types of lasers and their applications. This course also makes a foundation for advanced courses such as optical fiber communication and photonic devices.

Course Content

UNIT-I **15 Lectures**

Introduction to Lasers: Definition of the Laser, Unique properties of a Laser, The laser spectrum and wavelengths, Population inversion, Pumping and characteristics of the laser beam, spontaneous andstimulated emission, coherence, Saturation intensity, Absorption and gain, Exponential growth factor,Threshold requirements for a Laser.

UNIT II **15 Lectures**

Laser Oscillations above threshold: Laser gain saturation, small signal gain coefficient, Optimization of Laser output Power, Laser output fluctuations, Laser spiking, Relaxation oscillations, Decay time of laser beam within an optical cavity, Basic laser cavity rate equations, Laser amplifiers, Propagation of high power, short duration optical pulse through an amplifier.

UNIT III **15 Lectures**

Laser pumping requirements and techniques: Excitation by direct pumping, excitation by indirect pumping, Specific pump and transfer processes, pumping geometries, pumping requirements, transverse pumping, End pumping, Diode pumping, Characterization of laser gain medium with optical pumping, Heavy particle pumping.

UNIT IV **15 Lectures**

Laser cavity modes: Longitudinal laser cavity modes, Fabry Perot resonator, Febry Perot cavity modes, longitudinal laser cavity modes, longitudinal mode number, requirement for the development of longitudinal laser modes, Transverse laser cavity modes, transverse mode frequencies, Mode characteristics, Effect of gain on mode, Types of pumping, Characteristics of a laser beam, Semiconductor Laser, CO2 Laser, Solid Lasers, He-Ne Lasers, Gaseous Lasers.

Textbooks:

- Lasers and Non-Linear Optics, B. B. Laud, New Age International Limited Publishers, New Delhi.

Reference book(s):

- Optics and lasers: including fibers and optical waveguides, Matt Young, Berlin; New York: Springer-Verlag, 1992.
- Principles of lasers, Orazio Svelto; and edited by David C. Hanna, New York Plenum, 1989.
- Understanding lasers: an entry-level guide, Jeff Hecht, New York: IEEE Press, 1994.
- Fundamentals of laser optics, Kenichi Iga; technical editor, Richard B. Miles, New York: Plenum Press, 1994.

BSPH812A	**DISSERTATION**	L	T	P	C
Version 1.0		0	0	0	6
Pre-requisites/Exposure	Practical exposure				
Co-requisites					

Course Objectives

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

Course Outcomes

On completion of this course, the students will be able to**:**

CO1. Carry out the extensive literature survey.

CO2. Learn to write and present technical reports/articles.

CO3. Learn to analyze various methods and techniques applicable to the topic to study and contribute to domain knowledge.

CO4. Learn to analyze/evaluate the result of the experiment carried out and present the results using data visualization methods.

Catalog Description

1. Students will be divided among faculty members of the Department for the supervision of the research work.

2. In the first week of Semester V, each faculty member will assign a suitable research topic to the students from the selected topics in the areas of chemical sciences.

3. The student will work on the assigned research topic during semesters V and VI in regular consultation with his/her assigned teacher.

4. The student will write a dissertation based on the research work carried out during Semesters V and VI and prepare two copies to be submitted to the office of the Head of the Department duly signed by the student and the supervisor in the sixth week of VI semester or a date decided by the HOD of the department.

5. Before preparing power point presentation and submission of dissertation, each student has to deliver a seminar talk on his/ her research project work on a date fixed by HOD, necessary suggestions have to be incorporated in the final draft of dissertation.

6. The student will make a power point presentation based on the work carried out and mentioned in the dissertation to the board of examiners appointed by the University.