University of Science & Technology, Bannu

Township Bannu, Khyber Pakhtunkhwa Pakistan, www.ustb.edu.pk

Department of Physics

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BS Physics 4 Years Program

Objectives of the Program

The aim of the BS Physics (4 year program) is to furnish the students with fundamental principles of Physics and overall understanding of the subject. The qualified graduates will be able to utilize the knowledge of Physics in practical life which will beneficial for the society. The basic aim of the program is to provide a quality education in the subject area to produce qualified individuals whom can compete for challenges of the modern world. The program will not only provide the firm foundations for the socio-economical needs of the graduates but this will also assist a graduate for obtaining further higher education in specialized fields of Physics.

The main objectives of BS 4-year program are:

- Students will be able to understand basics and fundamental principles of Physics
- To apply the understandings of physics principles in the daily life problems.
- Effective skills development in Physics and to enhance the individual's problem solution ability.
- Students will develop their individual skills which will be helpful in applying their knowledge to the real world.
- Students will develop their inherent learning ability and get motivation for self-education.
- Students will develop their writing and oral communication skills in English.
- Students will be able to work in a group.
- Students will build up practical experience in various laboratory techniques.
- To enable the students to design and conduct experiments and analyze experimental data.
- Students will develop cognitive and rational reasoning power so that to face complex and unforeseen problems and seek their solution
- To offer courses, necessary for the career develop in various government and public sector organizations.
- To develop in-depth understanding in some specialized areas in Physics according to tendencies, by opting for a number of elective courses.

Semester Wise Layout of the Courses

Total Credit Hours: 134

1st Year		
Semester 1		**18 Credit Hours**
Mechanics – I	Waves and Oscillation	Calculus -I
Computer Fundamentals	Functional English	Islamic Studies
Lab-I (Mechanics)	-	-
Semester 2		**18 Credit Hours**
Mechanics – II	Electromagnetic Theory—I	Calculus – II
Computer Programming	Technical & Business Writing	Pakistan Study
Lab-II (Electricity and Magnetism)	-	-
2nd year		
Semester 3		**16Credit Hours**
Concepts of Modern Physics	Electromagnetic Theory—II	Linear Algebra
• Optics • Probability and Statistics	Communication Skills	Lab – III (Optics)
Semester 4		**17 Credit Hours**
Atomic and Molecular Physics	Thermodynamics and Kinetic Theory	Numerical Methods and Differential Equations
• Pure Mathematics • Environmental Physics • Renewable Energy Resources	Computational Physics	Lab – IV (Modern Physics)
Lab-V (Computational Physics)	-	-

3rd Year		
Semester 5		**16 Credit Hours**
Electronics-I	Classical Mechanics	Mathematical Methods of Physics – I
Quantum Mechanics – I	Solid State Physics –I	Lab – VI (Electronics)
Semester 6		**16 Credit Hours**
Electronics -II	Nuclear Physics	Mathematical Methods of Physics – II
Quantum Mechanics – II	Solid State Physics –II	Lab-VII (Nuclear Physics)

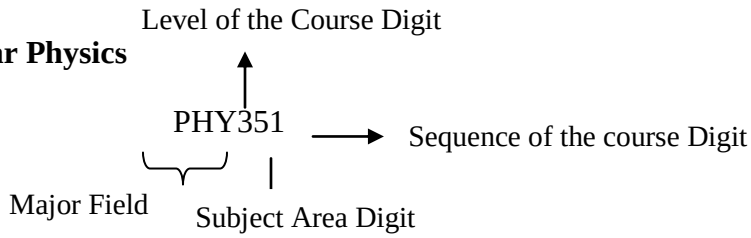
4th Year		
Semester 7		**18 Credit Hours**
Electrodynamics – I	Special Theory of Relativity and Tensor Analysis	Thermal and Statistical Physics
Optional Subject – I	Optional Subject – II	Optional-III
Semester 8		**15 Credit Hours**
Electrodynamics – II	Optional Subject – IV	Optional Subject – V
Optional Subject -VI	Project/ Optional Subject –VII	

NOTATIONS AND ABBREVIATIONS

A. Course Codes:

Every course offered at KUST is identified by a unique alpha-numeric code three letters followed by three digits. The letters represents the major field (Physics). The first digit represents the level of the course (or the year in which the course is normally offered). The second digit represents the broad area of the course. The third or the last digit stands for the sequence of the course offered in the same area. The schematic representation of the above detail is given below.

Example: **Atomic & Molecular Physics**



List of subject Area Digits (Middle digit in the course code)

S.No.	Middle digit in the course code	Subject Area
1	0	Introductory
2	1	Mechanics
3	2	Mathematical Physics
4	3	Thermal and Statistical Physics
5	4	Material Sciences
6	5	Atomic, Sub Atomic, and Optical Physics
7	6	Computational Physics
8	7	Electromagnetism
9	8	Plasma Physics
10	9	Laboratory / Project

Note: The **sequence of the course digit** is repeated for current year semesters.

1st Year
Semester I

Course Code	Course Title	Credit Hours	Pre-Requisite	Remarks
PHY-101	Mechanics – I	3		Introductory
PHY-102	Waves and Oscillation	3		Introductory
MTH-101	Calculus -I	3		Introductory
CSC-101	Computer Fundamentals	3		Introductory
ENG-101	Functional English	3		Introductory
HUM-101	Islamic Studies/Theology	2		Introductory
PHY-191	Lab – I Mechanics	1		
	Total Credit Hours	18		

1st Year
Semester II

Course Code	Course Title	Credit Hours	Pre-Requisite
PHY-103	Mechanics – II	3	Mechanics – I
PHY-171	Electromagnetic Theory—I	3	
ENG-102	Technical & Business Writing	3	Functional English
MTH-102	Calculus – II	3	Calculus – I
PS-101	Pakistan Study	2	
CSC-102	Computer Programming	3	Computer Fundamentals
PHY-192	Lab-II (Electricity and Magnetism)	1	
	Total Credit Hours	18	

2nd Year
Semester III

Course Code	Course Title	Credit Hours	Pre-Requisite
PHY-251	Concepts of Modern Physics	3	
PHY-271	Electromagnetic Theory—II	3	Electromagnetic Theory—I
ENG-201	Communication Skills	3	Functional English/ Technical & Business Writing
MTH-201	Linear Algebra	3	

PHY-252 MTH-202	• Optics • Probability and Statistics	3	Waves and Oscillation
PHY-291	Lab – III (Optics)	1	
	Total Credit Hours	16	

2nd Year Semester IV			
Course Code	**Course Title**	**Credit Hours**	**Pre-Requisite**
PHY-253	Atomic and Molecular Physics	3	Concepts of Modern Physics
PHY-231	Thermodynamics and Kinetic Theory	3	
MTH-203	Numerical Methods and Differential Equations	3	
PHY-261	Computational Physics	3	Computer Programming
MTH-204 PHY-232 * PHY-241 *	• Pure Mathematics • Environmental Physics • Renewable Energy Resources	3	Linear Algebra Concepts of Modern Physics
PHY-292	Lab – IV (Modern Physics)	1	
PHY-293	Lab-V (Computational Physics)	1	
	Total Credit Hours	17	
3rd Year Semester V			
Course Code	**Course Title**	**Credit Hours**	**Pre-Requisite**
PHY-301	Electronics-I	3	
PHY-311	Classical Mechanics	3	Mechanics – I/ Mechanics – II
PHY-312	Quantum Mechanics – I	3	Concepts of Modern Physics
PHY-341	Solid State Physics –I	3	
PHY-321	Mathematical Methods of Physics – I	3	
PHY-391	Lab –VI (Electronics)	1	
	Total Credit Hours	16	
3rd Year			

Semester VI			
Course Code	**Course Title**	**Credit Hours**	**Pre-Requisite**
PHY-302	Electronics -II	3	Electronics-I
PHY-313	Quantum Mechanics – II	3	Quantum Mechanics – I
PHY-351	Nuclear Physics	3	Quantum Mechanics – I
PHY-322	Mathematical Methods of Physics – II	3	Mathematical Methods of Physics – I
PHY-342	Solid State Physics –II	3	Solid State Physics –I
PHY-392	Lab-VII **(Nuclear Physics)**	1	
	Total Credit Hours	16	
4th Year Semester VII			
Course Code	**Course Title**	**Credit Hours**	**Pre-Requisite**
PHY-471	Electrodynamics – I	3	Electromagnetic Theory—I-II
PHY-421	Special Theory of Relativity and Tensor Analysis	3	Concepts of Modern Physics/ Quantum Mechanics – I
PHY-431	Thermal and Statistical Physics	3	
	Optional Subject – I	3	
	Optional Subject – II	3	
	Total Credit Hours	15	
4th Year Semester VIII			
Course Code	**Course Title**	**Credit Hours**	**Pre-Requisite**
PHY-472	Electrodynamics – II	3	Electrodynamics – I
	Optional Subject – III	3	
	Optional Subject -IV	3	
	Optional Subject –V	3	
	Project/ Optional Subject –VI	3	
	Total Credit Hours	15	

Note: The sequence of the course digit (last digit) is repeated for current year semesters.

Optional Courses				
S.No	**Course Code**	**Title of the Course**	**Credit Hours**	**Pre-Requisite**
1	PHY-451	Particle Physics	3	Quantum Mechanics – I/Quantum Mechanics – II
2	PHY-452	Experimental Nuclear Physics	3	Nuclear Physics
5	PHY-401	Digital Electronics	3	Electronics-I/ Electronics-II
6	PHY-402	Bio-Physics		
7	PHY-473	Laser	3	Atomic and Molecular Physics
	PHY-474	Optical Fiber and Applications		
8	PHY-422	Quantum Field Theory	3	Special Theory of Relativity/Quantum Mechanics
12	PHY-441	Solid State Electronic Devices	3	Solid State Physics –I/ Solid State Physics –II
	PHY-442	Semiconductor	3	Solid State Physics –I/ Solid State Physics –II
13	PHY-443	Materials Characterization Technique		
	PHY-444	Materials Science		Solid State Physics –I/ Solid State Physics –II
14	PHY-445	Nano-Physics and Technology		
	PHY-446	Lithography	3	
	PHY-481	Plasma Physics	3	Electrodynamics – I
15	PHY-482	Physics of Laser Plasma Interactions		
16	PHY-483	Astro-Physics		

PHY-101: Mechanics-I 3 Cr. Hrs

Course Objectives:

- To give concept of vector and their various properties.
- To give basic understanding of laws of motion and their applications is daily life.
- To give mathematical concept and expressions of various physical parameters used in mechanics.

Vector Analysis

Review of vector and fundamental operations, Direction cosines, Spherical polar coordinates, Cylindrical coordinates, Vector and scalar triple product, Gradient of a scalar, Divergence and curl of a vector and their Physical significance, Vector identities

Particle Dynamics

Dynamics of uniform circular motion: The conical pendulum, The rotor, The banked curve, Equations of motion, Kinetic equations for position and velocity via integration, Constant and variable forces, Normal forces and contact forces, Time dependent forces and relation for position and velocity via integration method, Terminal velocity, Projectile motion with and without air resistance, Drag forces and motion of projectile, Inertial and non-inertial frames, Pseudo forces: Coriolis force and Centrifugal force as an example of pseudo force

Work, Power and Energy

Work done by: a constant force and variable force (1-2 dimension), Expression for work done by the spring force, Kinetic energy and Work energy theorem, General proof of work energy theorem, Limitation of work energy theorem, Work and kinetic energy in rotational motion, Power, Conservation of energy, 1-2 and 3 dimensional conservative systems, Conservative and non conservative forces: Conservation of energy in a system of particles, Law of conservation of total energy of an isolated system.

Systems of Particles

Two particle systems and Many particle systems: Centre of mass, Position, Velocity, Acceleration and equation of motion, Centre of mass of solid objects: Uniform Rod, Cylinder and Sphere, Conservation momentum in system of particles, Momentum change in a system of variable mass, Application to motion of a rocket (determination of its mass as a function of time)

Collisions

Elastic and inelastic collision, Collisions in 1 and 2 dimensions, Conservation of momentum and ballistic pendulum, Collisions in center of mass reference frame, Elastic collision and two pendulums, Systems with varying mass, A. Rocket

Recommended Books:

- "Fundamental of Physics" by Halliday, Resineck and Krane volume1 (5th Edition).
- "An Introduction to Mechanics" by D. Kleppner and R. Kolenkow, (1978).
- "Vector Analysis and an Introduction to Tensor Analysis" by M. R. Speigel, (1959).

PHY-102: Waves and Oscillation 3 Cr. Hr

Course Objective:

- To understand the basics of waves, mechanism of wave production, propagation and interaction with other waves
- Use of basic concept of waves in their application in daily life

Waves

Wave motion, Kinds of waves, Transverse and longitudinal waves, Different parameters of a wave: Wavelength, Amplitude, Phase, wave number, Frequency, Period and angular frequency, Waves in a string: Speed, Energy and power of a wave travelling along a string, The wave equation, Superposition Principle, Interference of waves, Phasor, Standing waves and Resonance, Sound, The speed of sound, Formula derivation, Interference of sound waves, Intensity and sound level, The decibel scale, Sources of musical sound, Beats, The Doppler effect, Supersonic speed, Shock waves

Oscillation

Oscillatory motion, Hook's law, Simple Harmonic Oscillator: Amplitude, Velocity, Acceleration Frequency, Time Period, Energy of a simple harmonic oscillator, The block-spring system and its special cases, The simple pendulum, The swinging rod, Comparison of Simple Harmonic Motion with uniform circular motion, Damped simple Harmonic motion, Forced oscillation and resonance

Recommended books:

- "Fundamental of Physics" by Helliday, Resnick and J. Walker (8^{th} and 9^{th} Edition).
- "Contemporary college Physics" by Jones and Childers (3^{rd} Edition).

MTH-101: Calculus-I 3 Cr. Hrs

Course Objectives:

- To develop cognitive approach about number.
- To enhance and develop understanding about derivatives and functions.
- To give mathematical concept and expressions of derivatives via various rules and limits.

Real numbers limit and continuity

The real numbers system, Absolute values, Bound and bounded sets, Functions, Left and right limits of a function, Continuity of function and graphic representation.

Derivatives

The derivative of a function, Relationship between continuity and differentiability, Differentiation rules, Implicit differentiation, Chain rule, Derivative of trigonometric and inverse trigonometric functions, Derivative of hyperbolic and inverse hyperbolic functions, Logarithmic differentiation, Higher order derivatives , Leibnitz's theorem

Mean value theorem and indeterminate forms

Rolle's theorem, Lagrange's and Cauchy's mean value theorems, L'Hospital rule, Taylor's and McLaren's theorem, Indeterminate forms.

Plane curves

Curves and their representation in Cartesian, Polar and Parametric forms, Tangents and normal, Maxima, Minima and points of inflection, Asymptotes

Multivariable functions and partial derivatives

Function of several variables, Limits and continuity, Partial derivatives, The chain rule, Euler's theorem, Total differential and implicit functions, function maxima and minima of more than one variable without constraints

Recommended Books:

- "Calculus and Analytic geometry" by Zia-ul-Haq (1992).
- "Calculus and Analytic geometry" by Thomas and Finney (9th edition)**.**

CSC-101: Computer Fundamentals (2+1) Cr. Hr

Course Objectives:

- To provide Basic information about computers.
- To enhance the understanding of function of different computer parts.
- To improve Students skill to friendly use of computers.

Fundamental Computer Concepts

Software and its types: Application software, System software and their functions, Hardware and its types: I/O devices, Primary memory, secondary memory, CPU, Interconnection cables and their functions, Operating system and its function, Algorithm, Flow chart, Program and syntax of a program, Computer languages: Machine Language, Assembly language and High level language

Number System

Number systems: Binary, Octal, Decimal and Hexadecimal number system, Inter conversion of number systems, Addition, Subtraction, Multiplication and division of binary numbers

Boolean Algebra

Fundamental of Boolean algebra, Logic gates: NOT, OR, AND, NOR, NAND GATE and their respective Truth Tables

Data Communication and Network

Communication system, Basic components of communication system, Data transmission modes: Simplex, Half duplex, Full duplex, Synchronous and asynchronous transmission, Types of networks: LAN, MAN and WAN, Internet and its role in Physics, Web page, Website, Web browser, Search engine.

Practical:

Word processing, Spread Sheet, Power Point, Origin and web browsing

Recommended Books:

- "Computer fundamentals" by Pradeep K. Sinha and Priti Sinha.
- "Fundamental concepts of Computer System" by Asiya Sultan ali and Amena Nudrat.

ENG-101: Functional English 3 Cr. Hr

Course Objectives:

- To build the sound vocabulary of the students
- To improve the grammatical and Linguistics skills

Basics Units

Letter, Syllable, Word, Phrase, Clause, Sentence, Paragraph

Sentence Parts

Subject, Predicate, Types of sentences, Simple, Compound and Complex sentences

Parts of Speech

Definition & kinds
(Noun, Pronoun, Verb, Adverb, Adjective, Preposition, Conjunction, Interjection), Articles (Definition and indefinite)

Tenses & Grammatical Structures

- Tenses and usage (Present, Past & Future)
- Voices (Active & Passive voices)
  (Assertive, Interrogative, Imperative)
- Narrations (Direct & Indirect Narrations)
  (Assertive, Interrogative, Imperative, Exclamatory)
- Punctuation Marks (Period of full stop, Quotation Marks, Comma, Semi-colon, Colon, Dash, Hyphen, Apostrophe, Italics, or, underscore, Parenthesis, Ellipses, Exclamation Marks)

Comprehension Skills

- Similar Words (Words that confuse)
- Comprehension
- Précis or one third summary

Composition

Paragraph Writing, (Four Elements in Paragraphs)

Dialogue Writing

Suggested Reading:

- "High School English Grammar and Composition" by Wren and Martin.
- "Exploring the world of English" by Sadaat Ali Shah.

HUM-101: Islamic Studies/Theology 2 Cr. Hrs

Course Objectives:

- To provide basic information about Islamic values.
- To enhance understanding regarding Islamic Civilization.
- To enhance the skill of the students for understanding of issues related to faith and religious life.

Course Outline:

خاکہ نصاب اسلامیات (لازمی) یونیورسٹی آف سائنس اینڈ ٹیکنالوجی بنوں
برائے بیچلر کلاسیسز

باب اول: اسلام کے بنیادی عقائد

عقائد: توحید، رسالت، آخرت۔ ہر ایک عقیدہ سے متعلق 20,20 آیات مبارکہ

باب دوم: عبادات

باب سوم: امر بالمعروف ونہی عن المنکر۔ متعلقہ آیات واحادیث مبارکہ

باب چہارم:

۱۔کسب حلال: انعامی بانڈز، جی پی فنڈ، انشورنس، سٹہ بازی، گھڑ دوڑ، لاٹری

۲۔منشیات، ملاوٹ، ناپ تول، رشوت، جوا، اعضاء کا انتقال، پیوند کاری اور سودی کاروبار

باب پنجم:

۱۔حقوق العباد:

i۔ملکیت کا حق ii۔آزادی رائے وعقیدہ iii۔معاشی تحفظ

۲۔حقوق نسواں:

i۔اسلام کے روسے ii۔موجودہ مروجہ قانون کے روسے

باب ششم:

i۔ولادت نبیؐ ii۔عقد مواخات ومیثاق مدینہ iii۔غزوات iv۔حجۃ الوداع v۔آداب معاشرت

باب ہفتم: تہذیب

i۔اسلامی تہذیب کے عناصر ii۔اسلامی تہذیب کے عالمی اثرات iii۔اسلامی تہذیب کے اقوام عالم پر معاشرتی وسماجی اثرات

PHY-191: Lab – I (Mechanics)

PHY-103: Mechanics – II 3 Cr. Hr

Objectives:

- To give the basic concept of rotational motion, law of gravitation, physical properties of matter and relativistic mechanics
- Uses of above concepts in daily life in a scientific way

Rotational Dynamics

Relationships between linear & angular variables, Kinetic energy of rotation, Moment of Inertia, Newton's 2nd law for rotation, Parallel axis and Perpendicular axis theorems, Rotational inertia of disc, Bar and solid sphere, Rotational dynamics of rigid bodies, Equations of rotational motion and effects of torques, Combined rotational and translational motion, Rolling without slipping

Angular Momentum

Angular Velocity and angular momentum, Angular momentum for system of particles, Conservation of angular momentum, Torque and angular momentum, Stability of spinning objects and examples, The spinning Top

Gravitation

Universal Gravitational Law, Gravitation near the earth's surface, The two shell theorems, Gravitational potential energy, Potential energy of many particle systems, Escape velocity, Gravitational field, Kepler's Laws, Motion of planets and Satellites, Energy considerations in planetary and satellite motion, Application of gravitational law to the Galaxy.

Bulk Properties of Matters

Elastic Properties of Matter, Physical basis of elasticity, Tension, Compression & shearing, Elastic Modulus, Elastic limit. Poisson's ratio, Relation between three types of elasticity

Recommended Books:

- "Fundamental of Physics" by Helliday, Resnick and J. Walker (8th and 9th Edition).
- "An Introduction to Mechanics" by D. Kleppner and R. Kolenkow, (1978).

PHY-171: Electromagnetic Theory-I 3 Cr. Hr

Objectives

- To give the concept of electric field, electrical potential and dielectrics
- To understand the DC circuits
- To know the effect of magnetic field and basic magnetic properties of materials

Electric Field

Electric charge, Coulombs law , Electric field, Field Due to a Point charge: , Field Due to a Line of Charge, Field Due to a Continuous Charge Distribution, Ring of charge ,Disc of charge, A dipole in an Electric Field , The Electric Field Due to an electric dipole, Flux of an Electric Field, Gauss' Law: integral and differential form, applications of Gauss' Law: Planar Symmetry, spherical and cylindrical symmetry

Electric Potential

Electric Potential, Equipotential surfaces, Calculating the potential from the Field, Potential due to point charge, potential due to group of point charges, Potential due to an electric dipole, Potential Due to a Continuous Charge Distribution, Calculating the Field from the Potential, Electric Potential Energy of a System of Point Charges, Potential of a Charged Isolated Conductor

Capacitors and dielectrics

Capacitance, Electric field in a capacitor, Capacitors and capacitance of various shapes: Cylindrical, Spherical, Energy stored in an electric field. Energy per unit volume, Dielectric, Electric field of dielectric: An atomic view, Application of Gauss's Law to capacitor

D C Circuits:

Electric Current, Current density, Resistance, Resistivity, Conductivity, Ohm's Law, Energy transfer in an electric circuit, Equation of continuity, Current in a loop, multiple loops, loop voltage, Kirchhoff's 1^{st} & 2^{nd} law

Magnetic Field Effects

Magnetic field, Magnetic force on charge particle, Crossed electric and magnetic fields, Magnetic Force on a Current Carrying Wire, Torque on a Current loop, Biot Savart's law, Force Between Two Parallel wires, Ampere's law, Magnetic fields due to Solenoids and Toroids, Gauss's law for magnetism,

Recommended Books

- "Fundamental of Physics" by Helliday, Resnick and J. Walker (9^{th} Edition).
- "Introduction to Electrodynamics" by David Griffith (3^{rd} edition).

ENG-102: Technical & Business Writing 3 Cr. Hr

Course Objectives:

- To build technical skills of the students in English
- To improve written as well as oral skills of the students

Technical Writing Process

- Pre-writing, Writing, Post writing

Mechanical Layout of a Letter

- Letter parts-standard and optional parts of letter

Memorandum

- Memo parts and layout of a standard memo body

Resume (CV)

- Different parts of a standard resume

Report Writing

- Long Formal Reports (Parts)
- Short Reports (Essential Parts)
- Memo Reports (parts)

Thesis and Assignments Writing

Standard format/Essential parts

Oral Communication

- **Interview**
  - Steps/measures before an interview
  - Steps/measures during an interview
- **Meeting**
  - Purpose & kinds
  - Planning steps
  - Procedure during a meeting

Suggested Reading:

- "Effective Business Communication" by A. Murphy (7th Edition).
- "Business Communications Today" by Bovee.

MTH-102: Calculus –II 3 Cr. Hr

Objectives

- To develop the cognitive approach about integral.
- To enhance and develop understanding about two and three dimensional geometry.
- To give mathematical concept and expressions of integral via various rules and limits.

Anti-Derivatives

Definition, Integral of special functions, Integration by substitution, Integration by parts, Partial fraction, Integration of rational and irrational functions, Integration of trigonometric functions

Definite Integrals

Definition, The definite integral as limit of a sum, Properties of definite integral, Reduction formulae, Numerical integration, Evaluation of improper integrals with special reference to Gamma function

Multiple Integrals

Double integrals, Double integrals in polar form, Triple integral in rectangular coordinates, Triple integral in cylindrical and spherical coordinates

Two-Dimensional Analytical Geometry

Translation and rotation of axes, General equation of the second degree, Classification of conic section, Conic section in polar coordinates, Tracing of conics

Three-Dimensional Analytical Geometry

Rectangular coordinates system, Direction cosines, direction ratios and angles between two lines, Standard form of line and plane equations, Intersection of planes and lines, Distance between points, Lines and planes, Introduction to Spherical, polar and cylindrical coordinates system

Recommended Books:

- "Calculus and Analytic geometry" by Zia-ul-Haq.
- "Calculus and Analytic geometry" by Thomas and Finney, (9^{th} Edition)**.**

PS-101: Pakistan Studies 2 Cr. Hr

Objectives

- To develop vision of historical perspective, government, politics, contemporary Pakistan, ideological background of Pakistan
- Study the process of governance, national development, issues arising in the modern age and posing challenges to Pakistan

Historical Prospective

- Ideological rationale with special reference to Shaikh Ahmad Sirhindi, Shah Waliullah, Sir Syed Ahmad Khan.
- Educational Movements
- Aligarh
- Anjuman Himayat-e-Islam.
- Sindh Madrasah and Islamia College Peshawar

The Pakistan Ideology

- Definition and Explanation of Pakistan Ideology.
- The Pakistan Ideology and Allama Iqbal.
- The Pakistan Ideology and Quaid-e-Azam.

Muslim Political Struggle

- Formation of All India Muslim League, 1906.
- Lucknow Pact, 1916.
- Khilafat Movement, 1919.
- Nehru Report, 1928.
- Fourteen Points of Qaid-I-Azam, 1929.
- Allama Iqbal`s Presidential Address at Allahabad, 1930.
- The 1937 Election and Attitude of Congress Ministries towards Muslims.
- The Pakistan Resolution, 1940.
- The 1940 Election and Transfer of Power.

Establishment of Pakistan

- Early Problems and Important Events

In Corporation of Islamic Provisions in the Constitutions of Pakistan and Political Development

- Objective Resolution
- Success and failure of democracy in Pakistan; causes and remedies
- The Islamic Clauses in the constitutions of Pakistan, 1956-1962 and 1973

Our Land Geographical

Unity, Location, Geographical Importance of Pakistan; Natural Resources

Recommended Books:

- "Pakistan Studies" by Dr Abdul Qadir and Qaumi Nisab Markaz.
- "Muslim Nationalism in India and Pak" by Hafiz Malik.
- "The Struggle for Pakistan" I H Quershi.

CSC-102: Computer Programming (2+1) Cr. Hr

Course Objectives:

- Familiarize the students with basic structured programming skills.
- To learn C++ structured programming techniques
- Enable the students to write programs for basic computing tasks.

Computer programming Concepts

Computer program, High level languages, 4th Generation Language (4GL), Editor, Compiler, Source program, Object program

Computer Program Basics

Basic program structure (Input, Output, Process), Constant, Variable, Data types, Operators, Expression, statement, Input/Output statements, Debugging procedures, Errors logical, Syntax

Transfer of Control Structures

Control structures: Unconditional (GOTO statement), Conditional (if, if else, nested and switch statement)

Repetition

For structure, While structure, Do while structure

Arrays

Introduction to arrays, Types of arrays: Single dimensional and Multi-dimensional arrays

Functions and Subprograms

Functions, Passing arguments to function: Pass by value and pass by address, Recursion

Recommended Books:

- "Program Designing With Pseudo-Code" by Bailey and Lundgaard.
- "Programming in C++" by Rober Lafore.
- "How to Program C++" by Ditel & Dietal.

PHY-192 Lab –II (Electricity and Magnetism)

Note

- The students must perform at least 07 experiments from the list given below.
- 50 % of marks is given for performing experiments and
- 50 % of marks to viva about apparatus, theory of experiments and estimation of errors.

List of Experiments

- Verify the Ohm's Law and determine the resistance and resistivity.
- To determine the spring constant.
- Determination of current and voltage on two constantan wires with different lengths.
- Determination of current and voltage on four Constantan wires with different cross-sectional areas.
- Comparison of current and voltage on constantan and brass wire.
- Determination of current and voltage of different resistors in parallel (KCL).
- Determination of current and voltage of different resistors in series (KVL).
- To find the resonance frequency using RLC series resonance AC circuit.
- To determine the resonance frequency using RLC parallel resonance AC circuit.
- To find the impedance in resistor-inductor and resistor-capacitor circuit.
- To find the impedance in resistor-inductor-capacitor (RLC) circuit.

PHY-251: Concepts of Modern Physics 03 Cr. Hr

Objectives:

1. To give the concept of modern physics
2. To know about the dual nature of light
3. To understand the interaction of light with matter
4. To learn Energy Levels and Spectrum of Hydrogen atom

Particle Nature of Waves

Electromagnetic Waves: Coupled electric and magnetic oscillations, Blackbody Radiation, Photoelectric Effect, Compton Effect, Pair Production, Annihilation of matter, Photons and Gravity

Wave Nature of Particles

Wave description and its general formula, De Broglie Hypothesis, Phase and Group Velocities, Particle Diffraction: The Davisson-Germer experiment, Correspondence Principle, Wave function, Time dependent and time independent Schrodinger wave equation, Particle in a Box: Energy quantization, Heisenberg's Uncertainty Principles and its applications

Atomic Physics

The atoms and electron orbits, The planetary model and its failure, Origin of atomic spectra and spectral series, The Bohr theory of atom, Energy levels and spectrum of Hydrogen atom, Angular momentum of electrons, Electron spin, X-Rays, Continuous and Characteristics X-Rays, X-Ray Diffraction, Atomic Excitation, The Laser

Recommended Books

- "Concepts of Modern Physics" by Beiser (6^{th} edition).
- "Fundamental of Physics" by Halliday, Resineck and Krane volume 2 (5^{th} Edition).
- "Modern Physics by Ronald gautreau" and William savin, Schaum's outline series.

PHY-271: Electromagnetic Theory-II 3 Cr. Hr

Objectives

- To develop the cognitive approach about current and related phenomena.
- To enhance and develop understanding about effects of magnetic fields.
- To give mathematical concept and expressions of electromagnetic waves.

Induction And Inductance

Faraday's law of Induction, Lenz's Law, Induction and Energy Transfer, Eddy Current, Induced Electric Fields, Inductor and Inductance, Inductance of a Solenoid, Self Induction, Energy stored in a magnetic field, Energy Density of a Magnetic Field, Mutual Induction

Electromagnetic Oscillation and Alternating Current

Qualitative and quantitative description of LC Oscillation: The block-Spring Oscillator, The LC Oscillator, Charge and Current Oscillations, Electrical and Magnetic energy Oscillations, The Electrical-Mechanical Analogy, Damped Oscillations in an RLC Circuit, Alternating Current, Forced Oscillations, Three Simple Circuits: Resistive Load, Capacitive Load, Inductive Load, RLC Series Circuit, Power in AC Circuits, The Ideal Transformer

Maxwell's Equations and Electro Magnetic Waves

Induced Magnetic Field, Displacement Current, Maxwell's Equations: Integral and differential forms, Maxwell's Rainbow, The Traveling Electromagnetic Wave: Determination of speed of light from Maxwell's Equation, Speed of light and the induced electric and magnetic fields, Energy Transport and the Poynting Vector, Polarization of EM Wave, Reflection and Refraction of Wave, Total Internal Reflection

Recommended Books

- "Fundamental of Physics" by Helliday, Resnick and J. Walker (9^{th} Edition)
- "Introduction to Electrodynamics" by David Griffith (3^{rd} edition).

ENG-201: Communication Skills 3 Cr. Hr

Course Objectives:

- To develop the communication skills of the students.
- To improve the Linguistics skills in various situations.

Introduction to communication

- Definition and concept of communication
- Process of communication
- How Appearance communicates
- How body language communicates
- How silence, time and space communicate
- Flow/channels/kinds of communication
- Barriers to effective communication

The seven C's of effective communication

(Completeness, Conciseness, Consideration, Concreteness, Clarity, Courtesy, And Correctness)

Oral Communication

Interview

- Steps/measures before an interview
- Steps/measures during an interview

Presentation & speech

- Measure and procedure

Workshop & Seminar

- Planning and Conduct

Communication strategies

- Strategies for improving oral presentations
- Persuasive speaking

Proposal writing

- Deification, concept
- Kinds and purposes
- Parts of proposal

Written Communication

Essay Writing

- Methods and development
- Characteristics of a good essay

Suggested Reading:

- "Effective Business Communication" by A. Murphy (7^{th} Edition).
- "Bovee Business Communications Today" by Herbert W. Hilderbrandth, James and Thomass.
- "Exploring the world of English" by Sadaat Ali Shah.

MTH-201: Linear Algebra 3 Cr. Hr

Objectives

- To develop the cognitive approach about groups.
- To enhance and develop understanding about vector space.
- To give mathematical concept and expressions of matrices and Eigen Value problems.

Group Theory

Definitions and examples, Order of a group, Order of an element of a group, Subgroups, Cyclic groups, Cosets and Lagrange's theorem, Permutation, Homomorphism.

Vector Space:

Field, Vector spaces and their examples , Subspaces and their examples, Linear dependence and independence, Basis and dimension of finitely spanned vector spaces, Linear transformation of vector spaces, Kernel spaces, Image space and the relation between their dimension.

Matrices:

Matrix, Algebra of matrices, Inverse of a matrix, Elementary row operations, Rank of a matrix, Orthogonal matrices, Hermitian matrices, Determinant of a matrix: properties and their evaluation, Matrix of a linear transformation, System of linear equation , Gaussian elimination method, Gauss Jorden method,

Eigen value problems

Eigen values and eigen vectors of matrices, Matrix Eigen value problems, Similarity transformation, Diagonalization of matrices, Applications of Eigen values and Eigen vectors.

Recommended Books:

- "Mathematical Techniques" by Dr. Karamat Dar, Irfan-ul-Haq and M. Ashraf Jajja (1998)
- "Theory of groups" by Dr. Abdul Majeed.
- "Advanced Engineering Mathematics" by Erwin Kreyszig (9^{th} Edition).
- "Introductory Linear Algebra with Application" by Bernard Kolman and David R. Hill, (7^{th} Edition).

PHY-252: Optics 3 Cr. Hrs

Course Objectives:

- To understand the concept of reflections, refraction, interference, diffraction and polarization
- To develop understanding about the optical devices

Geometrical Optics

Geometrical optics and its laws, Sign convention, Refraction at a spherical surface, Lens formula, Lens formula by deviation method, Two lens systems, Aberrations, Review of topics related to chromatic aberration, Chromatic aberration, Eye pieces, Fiber optics.

Polarization

Plane elliptically and circularly polarized light, Production of each type and their uses, Malus law, Polarizing angle and Brewster law, Uni-axial crystals, induced optical effects, Optical activity in liquids

Interference

Far field approximation, Analytical treatment of interference phenomenon, Point source and extended source, typical cases of interference phenomena: Thin films, Fabry Perot & Michelson interferometer, Fresnel's biprism, Holography

Diffraction

Huygen's principle, Fraunhofer diffraction, Fresnel diffraction, Diffraction by a single slit, Diffraction pattern of a rectangular aperture, Diffraction pattern of a circular aperture, Resolving power of lenses, Double slit diffraction pattern, Diffraction grating, Dispersing properties of prism and grating, X-ray diffraction, neutron and electron diffraction. Study of Fourier theorem and its analysis, Application to grating, Diffraction applications

Recommended Books:

- "Introduction to Optics" by E. Hecht and Addison (1987).
- "Fundamental of Physics" by Halliday, Resineck and Krane volume1 (5^{th} Edition).

MTH-202: Probability and Statistics 3 Cr. Hrs

Course Objectives:

- To learn different modes of the data collection.
- To learn the data processing and analysis.
- To improve the reasoning and cognitive skills.

Classification of data

Classification of data, Principles of classification, Simple, Multiple and Component bar chart, Rectangle charts, Pictogram and Pie chart, Arithmetic mean, Geometric mean, Harmonic mean, Median, Mode, Variance and Standard deviation, Coefficient of variation, Properties of variance and standard deviation,

Probability Functions

Probability; Laws of probability, Conditional probability, Dependent and independent probability, Discrete and random variables and its probability distribution, Continuous and random variables and its probability density function. Median and mode of continuous random variables, Binomial probability distribution, Poisson distribution

Data Analysis

Curves fitting; Approximating curves and the principles of least square, Straight line, Second and higher degree parabola, Exponential and other type of curves, Criteria for suitable curve, Finding fitting values by least square method.

Recommended book:

- "Introduction to statistical theory" by Sher Muhammad Chudary.

PHY-291 Lab – III (Optics) 01 Cr. Hr

List of Experiments

1. Setting up a Michelson interferometer on the laser optics base plate.
2. Determining the wave length of the light of an He-Ne laser using a Michelson interferometer.
3. Newton rings Experiment.
4. Determine the wave length of laser using diffraction grating of known spacing.
5. Determine the grating spacing using known wavelength (laser).
6. Determination of velocity of light in air.
7. Determine the moment of inertia of a rod.
8. Determine the moment of inertia of a rotating disk.
9. Determine the moment of inertia of a rotating sphere.
10. To observe the magnetic field around a single wire.
11. To observe the magnetic field around single and double loop.
12. To observe the magnetic field of solenoid.

PHY-253: Atomic and Molecular Physics 3 Cr. Hr

Course Objectives:

- To learn about the developmental stages of modern atomic concepts.
- To develop the scientific approach of describing different phenomena.

Atomic Structure of Matter

Atomic Models (Dalton's atomic model, Thomson's atomic model), Rutherford's Nuclear atom model and its drawbacks, Rutherford scattering, Hydrogen Spectrum, Bohr's theory of the Hydrogen Atom and its drawbacks, Finite Mass Correction, Summerfield model, Frank-Hertz experiment, Stern-Gerlach experiment, Schrodinger's equation for Hydrogen atom.

Space Quantization And Periodicity

Space Quantization, Spinning electron, Angular Momenta and Magnetic Momenta, Orbital angular Momentum, Electron spin and Spin Quantum Number, Total angular Momentum of electron, Magnetic Quantum Numbers, Coupling Schemes(L-S Coupling and JJ-Coupling), Selection Rules, Pauli's Exclusion Principle, Zemann effects (normal and anomalous).

Molecular Structure And Spectra

Ionic and Covalent Bonding, Diatomic molecular-rotational-vibrational and electronic spectra, polyatomic molecules, Black Body Radiation, Einstein Coefficient and stimulated emission, Characteristics of laser beams, Resonators, Different types of lasers

Books Recommended

- "Modern Physics" by S.L. Kakani and S Kakani.
- "Principles of Modern Physics" by A, P. Sexana.
- "Perspectives of Modern Physics" by Arthur Beiser.
- "Physics of atoms and molecules" by B. H. Bransden and C. J. Joachain, (1983).

PHY-231: Thermodynamics and Kinetic Theory 3 Cr. Hrs

Course Objectives:

- To give the concept of heat and temperature
- To give the concept of classical distribution function
- To understand the laws of thermodynamics and their applications

Heat and Temperature

Macroscopic and microscopic descriptions of heat and temperature, Thermal equilibrium, The zeroth law of thermodynamics, Temperature scales, The Celsius and Fahrenheit scales, The triple point of water, The constant-volume gas thermometer, Thermal expansion (Linear expansion, volume expansion), The absorption of heat by solids and liquids: Heat capacity, Specific heat, Molar specific heat

Kinetic Theory and the Ideal Gas

Macroscopic properties of a gas and the ideal gas laws, Mean free path, RMS speed, Translational kinetic energy, The distribution of molecular speed, The molar specific Heat of an ideal gas and degrees of freedom, Equi-partition of energy, Boltzmann distribution law

The First Law of Thermodynamics

Thermodynamics, Energy in transit, The transfer of heat: Thermal Conduction, Convection, Radiation, The first law of thermodynamics, Heat of transformation, Heat capacity of solids, Work done on or by an ideal gas, The internal energy of an ideal gas, Molar heat capacity of solids at constant volume and pressure, Special cases of the first law of thermodynamics: Adiabatic, Isothermal, Isobaric and Isochoric Processes, Cyclic processes

Entropy and the Second Law of Thermodynamics

Reversible and irreversible processes, Entropy, Change in entropy, Entropy for irreversible processes, The second law of thermodynamics, Entropy and performance of engine, Carnot engine, the Carnot cycle, efficiency of a Carnot engine, Entropy in the Real World: Refrigerators

Recommended Books:

- "Fundamental of Physics" by Halliday, Resineck and Walker, volume1 (9th Edition)
- "Physics for scientist and engineers" by serway, Biechner, (5th Edition)
- "University Physics" by Hugh D.Young, Roger A.Freedman, A.Levis Ford (12^{th} Edition)

MTH-203: Numerical Methods and Differential Equations 3 Cr. Hr

Course Objectives

- To give concept of solution to the problems through nonconventional methods
- To give mathematical concept, expressions and solution of deferential eq. of higher order

Numerical solution of non-linear equations

Numerical methods: Iteration formula $x_{n+1}= f(x_n)$, Bisection method, Aitken's Δ^2 process, Newton Raphson method, The secant method, False position method

Numerical solution of simultaneous linear equations

Gauss elimination method, Gauss Jorden method, Method of inversion of matrices, Choleski's factorization method, Jacobi iterative method, Gauss Seidel method, Diagonal dominance theorem

First order Differential equations

Basic concepts and ideas, Formation of a differential equations, Separable differential equations, Homogenous and non-homogenous differential equations, Exact and non-exact differential equations, First order linear differential equations, Bernoulli's differential equations, Orthogonal trajectories of curves, First order non linear differential equations

Linear differential equation of second and higher order

Homogenous linear equations of second order, Second order homogenous equations with constant coefficients, Differential operators, Euler-Cauchy equation, Legendre's linear equation, Solution of non-homogenous equations, Solution by undetermined coefficients, Solution by parameters variation, Higher order linear differential equations, Higher order homogenous equations with constant coefficients , Higher order non homogenous equations.

Recommended Books:

- "Mathematical Techniques" by Dr. Karamat Dar, Irfan-ul-Haq and M. Ashraf Jajja (1998).
- "Advanced Engineering Mathematics" by Erwin Kreyszig (9th Edition).
- "An introduction to Numerical Analysis" by Dr. Muhammad Iqbal.

PHY-261: Computational Physics 3. Cr. Hrs.

Computer Languages:

Fundamentals of a digital computer and its uses, Hardware and Software concepts, Introduction to I/O devices, Operating systems (Dos, Windows, Unix, etc), Format statements, Control statements, Introduction to algorithm development and flow chart writing, Introduction to a Programming language C++, Introduction to data types, C++ program Repetition structures; Introduction to FOR, WHILE and DO-WHILE loops, Introduction to decision making structures; IF, IF-ELSE, Switch Statements, Introduction to Functions **a**nd arrays

Numerical Analysis:

Error and Sources of errors, Gross error, Rounding errors, Truncation errors, Finite difference, finding difference using Newton forward scheme, backward and central scheme (Stirling Formula), Basic concept of interpolation and finding Interpolation using Lagrange's formula, Basic concept of Numerical integrations, Finding integration using Trapezoidal rule and Simpson's $1/3^{rd}$ rule, Ordinary differential equations, Solution of ODE using Euler's Method, Non Linear equations, Finding solution of Non linear equation by Simple Iterative method, Bi-section method and Secant method, Linear system equation concept, Finding solution of linear system equation by Gaussian elimination method, Implementation of all above in C++

- Lab Practice for writing programs for Maths and physics problems; Projectile motion, Motion of freely falling object, SHM, Electric circuit Analysis, etc.

Books Recommended:

- “Object oriented programming in C ++” by Robert Lafore.
- “Numerical Analysis with C ++” by S A. Bhatti and N A. Bhatti.
- "Introduction to Computational Physics” by “M. L. De Jong, (1991).
- “Computational Physics” by S. T. Koonini, (1986).
- “Numerical Methods for Engineers with Personal Computer Applications” by S. C. Chapra and R. P. Chanle, (1965).

MTH-204: Pure Mathematics 3 Cr. Hrs

Course Objectives:

- To learn about set and functions
- To Understand the topological spaces, bases and continuity

Theory of Sets and Metric Spaces

Sets and subsets, Set operations, Indexed families of set, Functions, Inverse functions, Matrics on sets, Open balls and open sets, Neighborhoods, Interior, Closed sets, Closure, Subspaces, Sequences in metric spaces

Topological Spaces

Topological and Topological Spaces, Comparison of topologies, Neighborhood, Closure, Interior, frontier and exterior, Subspaces, Relative closure

Bases and Sub Bases

Bases, Base for usual topology on the line and the plane, Alternative definition of bases, Base at a point, sub bases, Generation of topologies

Continuity and Homeomorphism

Continuity in metric spaces, Continuity in topological spaces, Homomorphism, Topological properties

Recommended Books:

- "Introductory set topology" by S.M Yahya.
- "Introduction to General Topology" by Muhammad Amin.

PHY-232: Environmental Physics 3 Cr. Hr

Course Objective:

- To become familiar with the essentials of environment and Global climate
- To learn about the pollution factors in the environment
- To learn about the factors those influence the environments.

Basic Environmental Spectroscopy

Black body radiation, The emission spectrum of sun, The transition electric dipole moment, The Einstein Coefficients, Lambert – Beer's law, The spectroscopy of bi-molecules, Solar UV and life, The ozone filter

The Global Climate

The energy Balance, Zero-dimensional Greenhouse Model, elements of weather and climate, climate variations and modeling

Transport of Pollutants

Diffusion, ground water, Flow equations of fluid Dynamics, Turbulence, Turbulence Diffusion, Gaussian plumes in air, turbulent jets and planes

Noise

Basic Acoustics, Human Perceptions and noise criteria, Reducing the transmission of sound, Active control of sound

Radiation

General laws of Radiation, Natural radiation, Interaction of electromagnetic radiation and plants, Utilization of photo synthetically active radiation

Atmosphere and Climate

Structure of the atmosphere, Vertical profiles in the lower layers of the atmosphere, Lateral movement in the atmosphere, Atmospheric Circulation, Cloud and Precipitation, The atmospheric greenhouse effect

Climatology and Measurements of Climate Factor

Data collection and organization, Statistical analysis of climatic data, Climatic indices, General characteristics of measuring equipments, Measurement of temperature, Air humidity, Wind velocity, weather stations

Books Recommended:

- "Environmental Physics" by Egbert Booker and Rienk Van Gron Belle, (2^{nd} Edition).
- "Physics of Environmental and Climate" by Guyot (1998).

PHY-241: Renewable Energy Resources 3 Cr. Hr

Course Objective:

- To learn about the importance of renewable energy.
- To learn about the different potential resources of energy

Energy Scenarios

Importance of energy, World primary energy sources, Energy demand, Reserves, growth in demand, life estimates and Consumption pattern of conventional energy sources: Oil, Gas, Coal, Hydro, Nuclear, Renewable energy and its sustainability

Solar Energy

Sun-Earth relationship, Geometry, Sun path and solar irradiance, Atmospheric effects, Global distribution, Daily and seasonal variations, Sun shine hours, Air mass, Hourly, Monthly and Annual mean, Radiation on tilt surface, Measuring instruments

Photovoltaic

PV effect, PV materials, Solar cell working, Efficiencies, Different types of solar cells and their characteristics, Efficiency limiting factors, Power, Spectral response, Temperature effect, PV system sizing, Designing, Performance and applications

Wind

Global distribution, Wind speed, Height and topographic effects, Power extraction for wind energy conversion, Wind mills and their types, Wind mills for water lifting and power generation, Environmental impact

Hydropower

Global resources and classification, Micro, Mini, Small and large resources, Principles of energy conversion; Turbines and their types, Working and efficiency of power systems, Environmental impact

Biogas and Hydrogen Fuel

Biomass sources, residue, farms, forest. Solid wastes: agricultural, industrial and municipal wastes, traditional and non-traditional uses, Environment issues Importance of H_2 as energy carrier, fuel cells: types, applications

Nuclear

Nuclear fission, Nuclear Fusion, Nuclear reactor, radiation safety and hazards issues

Books Recommended

- "World Energy Supply, Resources, Technologies, Prospectives" by Manfred Grathwohl, Walter deGruyter-Berlin, (1982).
- "Renewable Energy Resources" by John W. Twidell and Anthony D. Weir (1986).
- "An Introduction to Solar Radiation" by Muhammad Iqbal (1983).
- "Solar Cells, Operating Principles, Technology, and system Application" by Martin A. Green, (1982).

PHY-292 Lab-IV (Modern Physics) 01 Cr. Hr

Note

- The students must perform at least 07 experiments from the list given below.
- 50 % of marks is given for performing experiments and
- 50 % of marks to viva about apparatus, theory of experiments and estimation of errors

List of Experiments

- Observe the bending of electrons in a uniform magnetic field.
- Variation in magnetic field due to change in accelerating potential.
- Determination of e/m ratio in a vacuum tube filled with H gas.
- Determination of specific charge on electron using Millikan oil drop experiment.
- To observe fringe shift using Michelson interferometer.
- Determining the wave length of the light of an He-Ne laser using a Michelson interferometer.
- Formation of Newton's Rings.
- To observe the Photo Electric Effect.
- Determination of plank's constant using different filters.

PHY-293: Lab-V (Computational Physics) 01 Cr. Hr

PHY-292: Lab –II (General Physics)

Note

- The students must perform at least 07 experiments from the list given below.
- 50 % of marks is given for performing experiments and
- 50 % of marks to viva about apparatus, theory of experiments and estimation of errors.

List of Experiments

- Determine the wave length of laser using diffraction grating of known spacing.
- Determine the grating spacing using known wavelength (laser).
- Determination of velocity of light in air.
- Determine the moment of inertia of a rod.
- Determine the moment of inertia of a rotating disk.
- Determine the moment of inertia of a rotating sphere.
- To observe the magnetic field around a single wire.
- To observe the magnetic field around single and double loop.
- To observe the magnetic field of solenoid.

PHY-301: Electronics-I 3 Cr. Hr

Objectives:

- To develop the understanding of different electronic circuit elements and devices like diode, transistors, amplifiers, oscillators and voltage regulators used in daily life alliances
- To understand the day to day electronic devices

Introductory Concepts

DC and AC circuit analysis, Voltage divider rules, Thevinin's theorem, Norton's theorem, Maximum power transfer, Loop analysis, Superposition theorem, r.m.s value of AC, Complex impedance, RC and RL Filters, Differentiating and Integrating Circuits.

Junction Diodes

Energy bands and Classification of materials, p-type and n-type semiconductors, p-n junction, p-n junction diode, I-V characteristics of diode, Reverse and forward biased diode, Applications of diode: Half-wave rectifier, Full-wave rectifier, Bridge full wave rectifier, Capacitor filters, Voltage doublers, Clipper and Clamper circuits,

Special Purpose Diodes

Zener diode, Zener voltage regulators, Varactor diodes, Schottky diodes, Light emitting diodes (LED), Photodiodes, Tunnel diodes

Recommended Books

- "Basic electronics" by James. J. Brophy, (5^{th} edition).
- "Electronic devices" by T. L. Floyd.
- "Electronics Principles" by P. Malvino.
- "Principles of Electronics" by V.K.Mehta and Rohit Mehta.

PHY-311: Classical Mechanics 3 Cr. Hr

Objectives:

- To develop the basic knowledge of classical world using the laws of Physics
- To develop the understanding of two bodies central force Problems
- To give understanding of kinematics and dynamics of rigid bodies
- Development of Hamiltonian equation and use of canonical transformation in classical physics

Elementary Principles

Brief survey of Newtonian mechanics of a single particle, Laws of Conservations for single particle, Motion of a system of particles, Conservation theorems for a system of a particles, Constraints, virtual work, Virtual work principle, D. Alemberts principle, Lagrange's equation and its applications.

Variational Principle

Calculus of variation, Euler Lagrange's equation and Hamilton's principle, Derivation of Lagrange's equation from Hamilton's principle, Applications of Hamilton's equation

Two Body Central Force Problem

Central forces, Equation of motion for a particle in central force field, Differential equation for the orbit under a central force field, Conservation of energy in a Central force field, Two body problem and its reduction to equivalent one body problem, Laboratory and the Centre of mass coordinate system and their mutual transformation , Kepler's Laws, Rutherford scattering.

Hamilton Equation of Motion and Canonical Transformation

Legendre's transformation and Hamilton equation of motion, Lagrange's Bracket, Canonical transformation and their examples, Poisson Brackets and their fundamentals, Hamilton's Canonical equation in terms of Poisson Brackets

Recommended Book

- "Classical Mechanics" by H. Goldstein, (3^{rd} edition).
- "Classical Mechanics" by N.C Rana and PS Joag.
- "Classical Mechanics" by M. Yar Khan.
- "Classical Mechanics of Particles and Systems" by Jerry B.Marion and Stephen Thonton.

PHY-312: Quantum Mechanics - I 3 Cr. Hr

Course Objective:

- To provide the comparison of the classical and quantum concepts.
- To learn about the wave function and uncertainty principles
- To learn about the Eigen functions and application of Schrodinger equations.

Review of Breakdown of Classical Concepts and Old Quantum Theory

Particle aspects of radiation and Plank's hypothesis, Wave aspects of matter and de Broglie's hypothesis, Discrete levels and Bohr's hypothesis

Functions of Wave Mechanics

Wave function, Physical interpretation of Wave function, Superposition of plane waves, Wave packet and the Einstein de Broglie relations, Wave function for a free particle, Schrodinger's equation, Postulates of Quantum Mechanics, Dirac notations, Function and Expectation value, Time development of Expectation value

Wave Packets and the Uncertainty Principle

Uncertainty Principle for a pair of Canonical Variables, Proof of Uncertainty Principle for a Wave Packet and the related Gedanken experiments, The Gaussian wave packet and spreading with time

Operators and Eigen Functions

Dynamical Variables and Operators, Eigen functions and Eigen values, Linear Operators, The Operator formalism in quantum mechanics, Orthogonal system, Hermitian Operator, Simultaneous Eigen function and the Commutators, The parity operator, The fundamental Commutation Rules, and quantization of classical dynamics, Equation of motion, Commutation Rules and the Uncertainty principle.

Application of Schrodinger's Equation for One Dimensional Problems

Principle of superposition of states, Probability density and current, Motion of wave packets, Ehrenfest theorem, Equation of continuity, Potential Step, Potential Barrier, Rectangular Potential Well, Linear Harmonic Oscillator and its wave function and their parity.

Books Recommended:

- "Introductory Quantum mechanics" by Richard L. Liboff.
- "Introduction to Quantum mechanics" by David J. Griffiths.
- "Quantum Mechanics" by N. Zittalli.

PHY-341: Solid State Physics -I 3 Cr. Hr

Course Objectives:

- To understand the concept of crystal systems and their properties
- To learn about the principles of X-Ray diffraction in different crystal systems.
- To know about the different inherent properties of the crystals

Crystal Structure

Periodic array of atoms , Lattice translation vectors, Basis and the crystal structure, Primitive unit cell, Wigner-Seitz unit cell, Bravais lattices, Two dimensional lattice types, Three dimensional lattice types, Miller indices for crystal planes, Inter planar spacing, Packing fraction, Index system and common crystal structures

Principle of X-Ray Diffraction

The incident beam (X-rays, neutrons, electrons), Bragg's law , Experimental diffraction methods: Laue method, Rotating crystal method, Powder method, Fourier analysis, Diffraction conditions, Equivalence of Bragg's and Laue Equations, Ewald construction, Brillion zones, Reciprocal lattice vectors, Reciprocal lattice to SC, BCC and FCC lattice, Structure factor of the BCC and FCC lattice, Atomic form factor.

Crystal Vibrations

Vibrations of crystal with monoatomic basis, First Brillion zone, Phase velocity, Group Velocity, Long wave length limit, Two atoms per primitive basis, Optical and Acoustical branch, Quantization of elastic waves, Phonon momentum, and Inelastic scattering by phonons.

Thermal Properties

Phonon heat capacity, Planck distribution, Normal mode enumeration, Density of state in one dimensions, Density of state in three dimensions, Debye model for density of states, Debye T^3 law, Einstein model of the density of states, General result for density of states.

Books Recommended:

- "Introduction to Solid State Physics" by C. Kittle, (7^{th} Edition).
- "Elementry Solid State Physics" by M. A. Omer.
- "Solid State Physics" by S. O. Pillai, (2003).

PHY-321: Mathematical Methods of Physics – I 3 Cr. Hrs

Objectives

- To give the understanding of Differential equations and their uses in Physics
- Introduction to special functions, Fourier Series, Fourier Transforms
- Solution of Boundary value problems and their uses

Vector Analysis

Review of Vectors algebra, Vector differentiation and gradient, Divergence and Gauss's theorem, Green's theorem in the plane, Curl and Stoke's theorem.

Complex Variables

Complex algebra, Function of complex number, Cauchy Reimann conditions and analytic functions, Countours, Cauchy Gourset theorem and Cauchy integral formula, Laurent's expansion, Singularities, Calculus of residue and its applications.

Fourier Series and Transforms

Definition of Fourier series, Examples of Fourier series, Fourier sine and cosine series, Complex form of Fourier series, Pointwise and mean convergence of Fourier series, Fourier transforms, Fourier integrals, Laplace's transform, its properties and applications.

Group Theory

Introduction to groups, Elements of group theory, Subgroups, Invariant subgroups, Mapping, Homomorphism, Isomorphism, Kernel, Vector space, Group representation, Continuous groups, O-groups, SU(2) groups, Lie groups.

Recommended Books:

- "Mathematical Methods" by G. Arfken.
- "Vector Analysis" by M. R. Spiegel.
- "Introduction to Mathematical Physics" by C. Harper.
- "Mathematical Methods in the Physical Sciences" by M L. Boss, (3rd edition).

PHY-391: Lab-VI (Electronics) 01 Cr. Hr

Note

- The students must perform at least 10 experiments from the list given below.
- 50 % of marks is given for performing experiments and
- 50 % of marks to viva about apparatus, theory of experiments and estimation of errors.

List of Experiments

- Recording the Current –Voltage characteristics of Zener diode.
- Recording the Current –Voltage characteristics of LEDs.
- Recording the Current –Voltage characteristics of Silicon and Germanium diodes.
- To design half wave rectifier and calculate the ripple factor without filter.
- To design half wave rectifier and calculate the ripple factor with capacitor, Choke and Pi-section filters.
- To design full wave rectifier and calculate the ripple factor without filter.
- To design full wave rectifier and calculate the ripple factor with capacitor, Choke and Pi-section filters.
- To construct full wave bridge rectifier circuit using four diodes and calculate the ripple factor without filter.
- To construct full wave bridge rectifier circuit using four diodes and calculate the ripple factor with capacitor, choke and Pi-section filters.
- To verify maximum power transfer theorem.
- To calculate the current value across load resistor by Thevenian Theorem.
- To calculate the current value across load resistor by Norton Theorem.

PHY-302: Electronics -II 3 Cr. Hrs

Transistors Circuits

Bipolar junction transistor, Common emitter, Common base and common collector amplifier, Biasing and stability, Switching circuits, Hybrid parameters, Power class A, B and C amplifiers,

Field Effect Transistor

Field effect transistor, FET characteristics, FET biasing techniques, FET amplifiers, MOSFET, MOSFET characteristics, MOSFET biasing techniques, Thyristors: Diacs, Triac, Uni-junction transistor

Operational Amplifiers

Ideal op-amplifiers, Simple op-amplifiers arrangements, Its data and sheet parameters, Feedback and stability, Non inverting and inverting circuits, op-amplifier applications: Comparators, Summing, Active filters, Integrator and differentiator

Oscillators

Hartley oscillator, Wien Bridge Oscillators, Phase Shift Oscillators, Colpitts Oscillators, Crystal Control Oscillators

RECOMMENDED BOOKS:

- "Electronic devices" by T. L. Floyd.
- "Electronics Principles" by A. P. Malvino.
- "Principles of Electronics" by V.K.Mehta and Rohit Mehta.

PHY-313: Quantum Mechanics – II 3 Cr. Hrs

Course Objectives

- To develop concepts about spherical symmetric system
- To understand the approximation methods and its applications in Quantum mechanics
- To learn about the identical particles

Spherically Symmetric Systems

The Schrödinger Equation for Spherically Symmetric potentials, The Hydrogen Atom, Angular Momentum

Matrix Formulation in Quantum Mechanics

Operators and state Functions as Matrices, Eigen Value Equations in Matrix from, Dirac Ket and Bra notations, Schrödinger, Heisenberg and Interaction Pictures, Harmonic Oscillator in Matrix Mechanics, Electron spin and Pauli Spin Matrices, Spin States for two Particles of spin ½

Perturbation Theory

Perturbation of non-degenerate and degenerate stationary states, Time Dependant Perturbation, Transition Probability and Fermi's rule, Variational method

Identical Particles

Principle of indistinguishability of identical particles, Generalized Pauli exclusion principle, Statistics of identical particles, Helium Atom, Symmetric and Anti-symmetric wave functions

Books Recommended:

- "Quantum Mechanics" by D. Griffith.
- "Quantum Mechanics" by N. Zittali
- "Quantum Mechanics" by Schiff.
- "Quantum Mechanics" by S. Merzbacher.

PHY-351: Nuclear Physics 3 Cr. Hrs.

Objectives

- To understand the constituent particles of a nucleus
- To learn about Radioactivity and nuclear reactions.
- To understand the different nuclear models.

Basic Properties of Nucleus

Nuclear size, Mass, Binding Energy, Nuclear Spin, Magnetic Dipole and electric quadrupole moment, Parity and statistics

Theories of Radioactive Decay

Theories of Alpha decay and explanation of observed phenomenon, Measurement of beta ray energies, Fermi theory of beta decay, Neutrino Hypothesis, Theory of gamma Decay, Nuclear isomerism

Nuclear Forces

Yukawa's theory of nuclear forces, Nucleon scattering (n-p scattering, p-p scattering, Deuteron theory), Charge independence and Spin dependence of nuclear forces, Isotopic Spin.

Nuclear Reactions

Conservation laws of nuclear reactions, Q- value and threshold energy of nuclear reaction, Reactions induced by protons, neutrons, deuterons and photons, Fission and Fusion of Nuclei, Energy released in Nuclear Fusion, Controlled thermonuclear Reaction.

Nuclear Models

Liquid Drop Model, Shell Model, Collective Model, Fermi Gas Model.

Books Recommended

- "Nuclear Physics" by Kaplan (1980).
- "Nuclei and Particles": by Segre, Bejamin, (1977).
- "Introducing Nuclear Physics" by Kenneth. S. Krane, (1995).
- "Concept of Nuclear physics" by B. L Cohen.
- "Nuclear Physics" by S. N Ghoshal.

PHY-322: Mathematical Methods of Physics – II 3 Cr. Hrs

Course Objectives

- To understand Differential equations and their uses in Physics
- To learn about different special functions
- To know about Eigen Values and Eigen Vectors of Matrices

Special Functions

Gamma Functions, Beta Functions, Bessel functions, , Integral form of Bessel Function, Legendre's Differential equation and Legendre's Polynomials and Generating Functions, Rodríguez formula for the Legendre's Polynomials, Laguerre Polynomials

Matrices

Linear Vector Spaces, Basic Definitions, Determinants, Matrices, Eigen Values and Eigen Vectors of matrices, Orthogonal matrices, Hermitian matrices, Similarity transformations, Diagonalization of matrices.

Differential Equations in Physics

First and second order linear differential equations, Partial differential equation of the theoretical physics, separation of variables, Homogenous differential equations, Non Homogenous differential equations.

Books Recommended:

- "Mathematical Methods" by G. Arfken
- "Introduction to Mathematical Physics" by C. Harper.
- "Mathematical Methods in the Physical Sciences" by M L. Boss, (3^{rd} edition)

PHY-342: Solid State Physics -II 3 Cr. Hr

- To learn about the crystal defects.
- To understand the Band Theory of solids.
- To Study the general electrical and magnetic properties of solids.

Crystal Imperfection

Introduction, Vacancy, Interstitial, Point imperfection, Line imperfections, Surface imperfections, Volume imperfections, Concentration of Point defect, Schottky and Frankel defect

Electrons in Crystal and Band Theory of Solid

Introduction, Conduction electrons, Free electron model, Electrical conductivity of Metal, Electrical Resistivity of Metal, Hall effect, Fermi surface, Thermal conductivity in metal, Energy bands in solids, Bloch theorem, Brillion Zone, Kronig-Penny Model, Metal, Insulator and semiconductor, Nearly free electron Model, Tight bonding Approximation

Dielectric Properties

Introduction, Dipole moment, Polarization, Electric field of a dipole, Local electric field of an atom, Dielectric constant and polarizability, Sources of polarizability, The classical theory of electronic polarizability, Dipolar polarizability, Ionic polarizability, Electronic polarizability

Magnetic Properties of Materials and Superconductivity

Introduction, Response of substance to magnetic field, Classification of magnetic materials, Magnetic susceptibility, Atomic theory of Magnetism, Langevin's classical theory of diamagnetism, Sources of Paramagnetic, Langevin's theory of Paramagnetism, Ferromagnetism, Ferromagnetic domain, Domain theory, Anti ferromagnetism, Sources of Superconductivity, Response of magnetic fields, Meissnere effect, Origin of energy gap, London equation, BCS theory of superconductivity, High temperature superconductor.

Books Recommended:

- "Introduction to Solid State Physics" by C. Kittle, (7^{th} Edition).
- "Elementary Solid State Physics" by M. A. Omer.
- "Solid State Physics" by S. O. Pillai, (2003).

PHY-392: Lab – VII (Nuclear Physics)

Note

- The students must perform at least 08 experiments from the list given below.
- 50 % of marks is given for performing experiments and
- 50 % of marks to viva about apparatus, theory of experiments and estimation of errors.

List of Experiments

- Recording (γ) radiations with a GM counter.
- Measuring the range of (α) radiation in air.
- Measuring the range of (β) radiation in air.
- Measuring the activity of a radioactive source (α, β and γ) using GM counter.
- Determine the half-life of α, β or γ source and plot the decay curve using GM counter.
- Determining the half-life of α, β or γ source and evaluating the decay curve using CASSY software.
- Ionization of air due to radioactivity.
- Confirming the law of distance for (β) radiation (Inverse square law).
- Attenuation of (β) radiation when passing through matter.
- To determine the absorption co-efficient for Gamma rays.

PHY-471: Electrodynamics -I 3 Cr. Hr

Course Objectives:

- To Study the rules governing the charge in static positions.
- To learn about the response of matter under electric and magnetic fields.

Electrostatics

Electric field, Continues charge distribution, Divergence and Curl of electrostatic fields, Gauss's law, Applications of Gauss's law, The curl of E, Electric Potential, The Potential of a localized charge distribution, Electrostatic boundary conditions. Work and energy in electrostatics, Work done to move a charge, Energy of a point charge distribution, The energy of a continuous charge distribution, Conductors, induced charges, Surface charge and force on a conductor, Capacitors.

Special Techniques

Laplace's and Poisson Equation, Laplace's equation in one dimension, Laplace's equation in two dimension, Laplace's Equation in three dimension, Uniqueness theorem and boundary conditions, Conductors and the second Uniqueness theorem, The method of images and its applications, separation of variables, Cartesian coordinates, Spherical coordinates. Multi pole expansion, approximate potentials at large distances, the monopole and dipole terms, Origin of coordinates in multipole expansions, Electric field and potential of dipole.

Electric Fields in Matter

Polarization, Dielectrics, Field of polarized objects, Bound charges, Field inside a dielectric, Electric displacement, Gauss's law in presence of dielectric, Boundary conditions, Linear Dielectrics, Susceptibility, Permittivity, Dielectric Constant, Energy in dielectric systems, Forces on dielectrics.

Magnetostatics

The Lorentz force law, Magnetic field, Currents, Magnetic Forces, Motion of charged Particle in Uniform Magnetic Field, Cycloid Motion, Biot-Savart law, Magnetic field of steady current, Divergence and Curl of B, Straight line currents, Ampere's law and its applications, Magnetic Field of a long Solenoid and Toroidal coil, Magnetic vector potential, Multipole expansion of vector potential, Magneto statics Boundary Condition.

Magnetic Fields in Matter

Magnetization, Torque and force on magnetic dipole field inside matter, Diamagnetism, Paramagnetism, and Ferromagnetism, Effect of Magnetic Field on Atomic Orbits, Field of a Magnetized Object, Bound Charges. H-field, Ampere law in magnetized materials, Linear and non linear magnetic media, Magnetic susceptibility and permeability, Ferromagnetism and Hysteresis loop, Boundary conditions

BOOKS RECOMMENDED:

- "An Introduction to Electrodynamics" D. Griffiths, (3rd edition).
- "Classical Electrodynamics" by H.C. Ohanion, (1988).

PHY-421: Special Theory of Relativity and Tensor Analysis 3 Cr. Hr

Objectives

- To learn about the Special theory of relativity
- To develop the ideas of relativistic mechanics.
- To understand the concept of four vectors.
- To know the invariance of electromagnetic systems

Introduction

Galilean Transformations, Michelson-Morley Experiment, Einstein Postulates, Intervals, Lorentz Transformations

Application of Lorentz Transformations

Life Span of a Meson, Clocks and Rods, Time dilation and Length Contractions, Simultaneity and Casualty, Clock Paradox, The Relativistic Transformation of Velocities, Successive Lorentz Transformations

Four Vectors

Introduction, Variation of Mass with velocity, World Vectors, Form of Newton's Second Law in Relativistic Mechanics, Relation between Mass and Energy

Lorentz Invariance of Physical Theories

Maxwell's Equations and the conservation of Charge, Maxwell's Equations and the Lorentz Transformations, Solution of Maxwell's Equations, Invariance of Electromagnetic Systems, The Lorentz Force

Tensors Analysis

Introduction, Rank of tensors, Tensor representation, Tensor Algebra (Addition, Subtraction, Multiplication), Quotient Law, Contraction of Tensors, Symmetric and Skew symmetric Tensors, Contravariant and Covariant Tensors

Books Recommended:

- "Special Theory of Relativity" by Muirhead.
- "An Introduction to Tensor Calculus and Relativity" by H.F. Lawden.

PHY-431: Thermal and Statistical Physics 3 Cr. Hrs

Objectives

- To understand thermodynamical properties of matter
- To learn about statistical distribution of particles in energy states.
- To understand the concepts of Thermodynamic functions.

Equilibrium Thermodynamics

Thermodynamics system, Thermodynamics variables and equation of state, Thermodynamics Equilibrium, Quasi-state process, Energy of a system, Energy transfer, Energy as a state function, First Law of Thermodynamics, Enthalpy, Steady state, Heat capacity, Second Law of Thermodynamics, Reversible and Irreversible process, Entropy, Clausius inequality , Thermodynamics identity, Absolute entropy and Third Law of Thermodynamics, Helmholtz and Gibbs energy, thermodynamics potentials, Relation of thermo dynamical potential with their variables, Basic postulates, Response functions, Maxwell relations

Classical Statistical Mechanics

Phase space description of physical system, Macro and Micro systems, Ensembles, Canonical and grand canonical ensembles, Probabilities, Distribution functions, Statistical Interpretation of Entropy, Maxwell Boltzmann Distribution, Ideal Gas.

Partition Function

Introduction, Translational, Rotational and vibrational partition function, Relations of partition function with thermodynamic variables as function of: Entropy, Free energy, Internal energy, Enthalpy, Gibbs energy, Pressure of gas, Heat capacity, Pauli and Van Vleck Paramagnetic, Diatomic molecules, Heat capacity of diatomic gases, Equipartition of Energy.

Quantum Statistics

Basic Concept of Quantum Statistics, Pauli Exclusion Principle, Fermi Dirac Statistical Distributions, Bose Einstein, Fermi Dirac Statistical systems, Black body radiation, Gas of Electron in solids

Books Recommended

- "Statistical physics" by F. Mandle, (2^{nd} edition).
- "Fundamentals of Statistical and Thermal Physics" by F. Reif, (1965).

PHY-472: Electrodynamics-II 3 Cr. Hrs

Time Dependent Electromagnetic Field

Electromotive force, Motional emf, EM-induction, Faraday law, Induced electric field, Induced electric field in terms of vector potential, Inductance, Self-inductance, Mutual inductance and its examples, Neumann Formula for Mutual induction, Magnetic energy, Magnetic energy in terms of Magnetic induction, Magnetic energy density

Maxwell's Equations and Electromagnetic Waves:

Maxwell's Equations, Magnetic charge, Displacement current, Maxwell's equations in matter, Boundary conditions, Continuity Equation, Conservation of momentum, Electromagnetic Waves, Waves in one Dimension, Wave Equation, Sinusoidal Waves, Plane EM Waves, Polarization, Waves in three dimensions Spherical waves, Energy and Momentum in EM-Waves, Poynting Theorem and Poynting Vector

Propagation of Electromagnetic Waves in Matter:

Propagation characteristics of EM waves in a non-conducting media, Conductors and Dielectrics, EM waves in conducting media, Propagation in good dielectrics, Propagation in good conductors, Intrinsic impedance of a medium, Depth of penetration (Skin Depth), Optical dispersion in materials, Force Oscillation of an electronic Oscillators, Resonance absorption by bound charges, Group velocity, The frequency dependence of Permittivity.

Reflection and Refraction of Electromagnetic Waves and Waves Guides:

EM-Waves in bounded media, Reflection and Refraction of plane wave at a dielectric boundary, Law of reflection and refraction, Normal incidence, Oblique incidence, Fresnel equations, Total internal reflection, Reflection from the surface of a conductor, Wave Guides, Wave Guided by Parallel Plane Conductor, Rectangular Wave Guide, dielectric Wave guide Wave guide as a Cavity resonator.

Recommended Books:

- "An Introduction to Electrodynamics" D. Griffiths, (3rd edition).
- "Classical Electrodynamics" by J.D. Jackson, (1975).
- "Electromagnetism" by I.S. Grant and W.R. Phillips, (1990).

OPTIONAL COURSES

PHY-481: Plasma Physics 3 Cr. Hrs.

Objectives

- To understand different parameter regarding plasma.
- To understand the aspects of plasma.
- To learn the wave and fluid nature of plasma.

Introduction

Occurrence of Plasma in nature, Definition of Plasma, Concepts of temperature, Debye Shielding, The plasma parameter, Criteria for plasma, applications of plasma Physics

Motion of a Single Particle

Motion of charged particle in uniform E and B fields, Non uniform E field, Time varying E field, Time varying B field, Summary of guiding centre drifts, Adiabatic Invariant

Plasma as a Fluid

Introduction, Relation of plasma physics to ordinary electromagnetics, The fluid equation of motion, Fluid Drift perpendicular to B, The plasma approximation

Waves in Plasma

Representation of waves, Waves propagation in plasma, Group velocity, Plasma Oscillation, Electron plasma waves, Sound waves, Ion waves, Validity of plasma approximation, Electrostatic electron oscillation perpendicular to B, Electrostatic ion oscillation perpendicular to B, Lower hybrid frequency, Electromagnetic waves with B0 =0, Electromagnetic waves perpendicular to B0, Cutoff and Resonances, Summary of elementary plasma waves

Books Recommended:

- "Introduction to plasma physics" by F.F. Chen, (2^{nd} edition).
- "Principles of Plasma Physics" by N.A. Krall and A.W. Trivelpiece, (1973).
- "Fundamentals of Plasma Physics" by Bitoncourt, (1987).

PHY-451: Particle Physics 3 Cr. Hrs

Objectives

- To learn about the elementary particles.
- To understand the relativistic and quntum approach of particles.
- To learn about scattering phenomena of particles.

Fundamental Interactions and Elementary Particles

Units used in high energy physics, Historical survey from 1930-1960, Discovery of neutron, Positron, neutrino meson theory of nuclear forces, Muons, Pions, Strange particles and anti particles. Basics interactions, Gravitational – electromagnetic-weak and strong interactions, Classification of particles statistic-wise and interaction-wise, Hadrons (baryons & mesons), Quarks, Leptons, Angular momentum, Spin, Parity, Isospin, Strangeness, Hypercharge, SU (2) Multiplets SU (3) multiplets

Relativistic Quantum Mechanics

Klein – Gordon equation, The Dirac wave equation for a free particle, Algebra of gamma matrices, Spin and magnetic moment of the Dirac particle, The hole theory, The Dirac equation for a particle of mass zero, Covariance of the Dirac equation under the Lorentz Transformation, The Dirac bilinear covariant.

Scattering Theory

Two body problem, scattering amplitude and Cross section, Calculation of cross section by phase – shift analysis at low energy, Born's approximation, the optical theorem.

Recommended Books

- "Quarks and Leptons" by Halzen and Martin, (1984).
- "Introduction to Elementary Particle Physics" by Griffiths (1984).
- "Quantum Mechanics" by Riaz ud din and Fayyaz udin (1990).

PHY-441: Solid State Electronic Devices 3 Cr. Hrs

Objectives

- To understand base of conduction mechanism in matter.
- To learn about rules governing the motion of charge carriers in semiconductor materials.
- To know about FET and BJT

Introduction

Review of crystallography, Band theory of solids, electron, holes and Recombination, Fermi level and Fermi energy, Bloch Theorem, Kronig-Penney Model

Junctions

Equilibrium conditions: The Contact Potential, Equilibrium Fermi level, Forward and reverse - bias junctions: Qualitative description of Current flow at a junction, Carrier injection, Reverse-Bias, Reverse Bias Breakdown: Zener Breakdown, Avalanche Breakdown, Rectifiers, The Breakdown diode, Metal-Semiconductor Junctions: Schottky Barriers, Rectifying Contacts, Ohmic Contacts

Field Effect Transistors

Transistor Operation: The Load Line, Amplification and Switching, The Junction FET: Pinch-off and Saturation, Gate control, Current-Voltage characteristics, The Metal-Semiconductor FET: The GaAs MESFET, The High electron Mobility Transistor (HEMT)

Bipolar Junction Transistors

Fundamental of BJT Operation, Amplification with BJTs, BJT Fabrication, Hetero-Junction bipolar transistors

Recommended Book:

- "Solid State Electronics Devices" by Ben G. Streetman and Sanjay Banarjee, (5th Edition)
- "Introduction to Solid State Physics" by C. Kittle, (7th Edition).
- "Elementry Solid State Physics, by M. A. Omer, (1974).
- "Solid State Physics" by S. O. Pillai, (2003).

PHY-442: Semiconductor Physics 3 Cr. Hrs

Objectives

- To understand the different parameters governing the semiconductor materials.
- To learn about carrier mobility in semiconductors.
- To know about electric and magnetic field effect on semiconductors.

Growth of semiconductors

Metals, Insulators and Semiconductors, Semiconductor materials, Periodic table and Semiconductors, Intrinsic and Extrinsic Semiconductors, n-type and p-type semiconductors, Bloch theorem, Kronig Penny Model

Energy Bands and Charge Carriers in Semiconductors:

Bonding forces in solids, Energy bands, Direct and Indirect Semiconductors, Charge Carriers in Semiconductors: Electrons and Holes, Effective mass, Carrier Concentrations: The Fermi level, Electron and hole concentrations at equilibrium, Temperature dependence of carrier concentration, Drift of Carriers in Electric and Magnetic fields: Conductivity and Mobility, Effects of temperature and doping on mobility, High field effect, The Hall effect

Excess Carriers in Semiconductors:

Optical Absorption; Luminescence: Photoluminescence, Electroluminescence, Carrier lifetime and Photoconductivity: Direct recombination of electrons and holes, Indirect recombination; Trapping, Steady state carrier generation; Quasi-Fermi levels, Photoconductive devices, Diffusion of Carriers: Diffusion Processes, Diffusion and drift of Carriers; Built-in fields, Diffusion and Recombination; The Continuity equation, Steady state Carrier injection; diffusion Length, Gradient in the Quasi-Fermi levels.

Recommended books:

- "Semiconductor Physics" by Neemons.
- "Introduction to Solid State Physics" by C. Kittle, (7^{th} Edition).

PHY-473: LASERS 3 Cr. Hrs.

Objectives

- To understand basics rules regarding laser production.
- To learn about concepts of resonators and their function.
- To know about laser types and their applications.

Introductory Concepts

Spontaneous Emission, Absorption, Stimulated Emission, Pumping and pumping methods, Absorption and stimulated Emission Rates, Absorption and Gain Coefficients, Resonance Energy Transfers. Properties of Laser beam: Monochromaticity, Coherence, Directionality, Brightness, active medium, Rate equations

Resonators

Optical Resonators: Plane parallel (Fabry-Perot) Resonator, Concentric (Spherical) Resonator, Confocal Resonator, Generalized Spherical Resonator, Unstable Resonator

Types of Lasers

Solid State Lasers: Ruby Laser, Nd: YAG and Nd: Glass Lasers, Semiconductor Lasers, Gas lasers: Helium Neon laser, Co2 laser, Free electron lasers

Laser Applications

Application in: Mechanical industry, Electronic industry, Nuclear energy, medicine, defense, Holography, Laser communication

Books Recommended:

- "An introduction to Lasers, theory and applications" by M.N. Avadhanulu, (2008).
- "Principles of Lasers" by O. Svelto, (1992).
- "Laser Fundamentals" by W. T. Silfvast.
- "Laser Theory" by H. Haken.

PHY-401: Digital Electronics 3 Cr. Hrs.

Objectives

- To learn about number systems.
- To understand basics rules regarding Boolean algebra.
- To develop the concept of logic gates and it applications.

Review of Number Systems:

Binary , Decimal, Octal and Hexadecimal number system, Their inter-conversion, Concepts of logic, Basic logic gates, Truth tables

Boolean algebra

Boolean algebra, Postulates of Boolean algebra, Laws of Boolean algebra (Laws of Complementation, AND Law, OR Law, Commutative Law, Associative Laws, Distributive Laws), De Morgan's theorem, Demorganization of Boolean Expression, , Different codes, (BCD, ASCII , Gray etc)

IC Logic Families

Basic characteristics of a logic family, (Fan in / out), Propagation delay time , dissipation, noise margins etc, Different logic based IC families (DTL, RTL, ECL, TTL , CMOS)

Combinational Logic Circuit

Logic Circuits based on AND –OR, OR –AND, NAND, NOR Logic, Gate design, Addition, Subtraction (2's compliments, Half adder, Full adder, Half subtractor, Full subtractor, Encoder, Decoder Multiplexer, D-Multiplexer

Sequential Logic Circuit

Flip-flops, Clocked RS-FF, D-FF , T-FF, JK-FF, Shift Register, Counters (Ring, Ripple , Up-down, Synchronous) A/D and D/A Converters

Memory Devices

ROM, PROM, EAPROM, EE PROM, RAM (Static and dynamic) Memory mapping techniques

Books Recommended:

- "Digital Logic and Computer Design" by Morris Mono (1995).
- "Principles and applications of digital electronics" by Larry D. Jones, (1993).
- "Digital Electronics" by Tochim, (1999).
- "Digital Fundamental" by T.L. Floyd, (8^{th} edition).

PHY-452: Experimental Nuclear Physics 3 Cr. Hrs

Objectives

- To develop the concept of nuclear detection systems and related measurements techniques.
- To learn about the particles accelerator and nuclear reactors
- To understand the nuclear reactions and their physics

Nuclear Detectors

Interaction of nuclear radiation with matter, Photographic emulsions, Gas-filled detectors, Scintillation counters and Solid-State detectors

Accelerators

Linear and orbital accelerators, Van de Graff, Cyclotron, Betatron, Synchrocyclotron, Electron-Synchrotrons; Proton-synchrotron

Neutron Physics

Neutron Sources, Reactor as a neutron source, Measurement of neutron cross-sections as a function of energy, Slowing down of neutrons, Nuclear fission, Description of fission reaction, Mass distribution of fission energy, Average number of neutrons released, Theory of fission and spontaneous fission, Nuclear chain reaction and applications

Elementary Reactor Physics

Controlled fission reactions, Types of nuclear reactors (Power and Research), Detailed study of PWR and CANDU type reactors

Books Recommended:

- "Radiation Detection and Measurement" by Glenn, F. Knoll, (1989).
- "Techniques for Nuclear and Particle Physics" by William, R. Leo, (1994).
- "Data Detection and Error analysis for physical sciences" by Philips Berington (2002).
- "Nuclei and Practicles" by Segre, (1977).
- "Introducing Nuclear Physics" by Kenneth S. Krane, (1995).
- "Particle and Nuclei" by B. Povh, K. Rith, C. Scholtz, F. Zetsche, (1999).

PHY-421: Quantum Field Theory 3 Cr. Hrs

- **Objectives**

- Give the Fourier expansions of scalar, Dirac and the photon fields
- Explain field quantization
- Explain symmetries and conservation laws in the Lagrangian formalism
- Explain the Feynman propagator and Feynman rules
- Explain regularization and renormalization
- Calculate cross sections for simple processes

Introduction to the course, Review of basic concepts of quantum mechanics, Review of basic concepts of Relativity, Spin Zero , Kline Gordon Equation , Dirac Equation, Lorentz Invariance , Free Scalar field theory, The Spin statistics theorem, Path integral quantization, Scattering, Amplitude , Renormalization, Free Fermion propagator, The Feynman rules, Discrete symmetries, Perturbation theory, Continuous symmetries, Course need currents, Discrete symmetries, The renormalization group, Spontaneous symmetry breaking, Spinor fields, Gama matrices, Lagrangian for Spinor fields, Canonical quantization of spinor fields, Parity, Time reversal, Charge conjugation, Free Fermion propagator, The Feynman rules for Dirac fields, Gama matrices, Loop correction in Yukawa theory, Functional Determinants, Spin one, Maxwell equation, Spinor electrodynamics, Beta functions in Quantum Electrodynamics, Non-abelian gauge theory, Anomalies in Global symmetries, Chiral Symmetry Breaking, The standard model, Gauge Sector, Higgs Sector, Lepton Sector, Quark Sector.

Books Recommended:

- Quantum Field Theory and the Standard Model 1st Edition by Matthew D. Schwartz Cambridge University Press; 2013
- An Introduction to Quantum Field Theory, Michael E.Peskin and Daniel V. Schroeder, Addison-Wesley Publishing Company, 1995
- Quantum Field theory, Mark Srednicki , Cambridge University Press, 2007
- Quantum field theory in Nutshell A.Zee, Princeton University Press, 2010
- Modern Quantum field theory , Tom Banks, Cambridge University Press, 2008

PHY-422: Cosmology 3 Cr. Hrs

- **Objectives**

- To understand the basics of the subject
- To learn about inflation and dark energy
- To be able to appreciate difficulties with Newtonian gravitation
- To be able to understand the theory of expansion of universe
- To understand the theory of inflation

Introduction, Background, Cosmology, Newtonian cosmology, Cosmological redshift, Hubble's law, Microwave Background, The Big Bang expansion rate, The Cosmic Microwave Background, Radiation (CMBR), Radiation domination, History of the universe, Isotropy, Homogeneity, Clustering properties of galaxies and large-scale structure, Friedmann equation, Difficulties with Newtonian gravitation, Mach's Principle, Robertson-Walker metric, Dark matter, Nucleosynthesis, The Early Universe, Inflation, The very early universe, Dark matter, Cosmological Principles, Measurements of distances, luminosities, angular sizes, etc. in the cosmological context, The Friedman models of classical cosmology, Observational tests of the Friedman models, The Anthropic Principle and Dirac's large numbers, Radiation-dominated expansion, The epoch of "recombination", Nuclear statistical equilibrium in the early Universe, Synthesis of the light elements, Measurements of primordial light element abundances, Baryon and lepton asymmetry in the early Universe, Equation of state for inflation, Fluctuation spectrum emerging from the inflationary epoch, Jeans' instability, Growth of density perturbations in Friedman models, Dissipation processes, Adiabatic and isothermal fluctuations in baryonic matter, Growth of fluctuations and damping processes in non-baryonic matter, Gravitational, adiabatic, and Doppler perturbations, Multipole expansion of temperature fluctuations, Non-linear collapse of density perturbations.

Books Recommended:

- J. V. Narlikar, Introduction to Cosmology, Cambridge University Press, 1989.
- Peter Coles *Cosmology: A Very Short Introduction*, Oxford University Press, 2001.
- Fred C. Adams and Greg Laughlin *The Five Ages of the Universe*, Simon & Schuster, 2000,
- Barbara Ryden, Introduction to Cosmology, Addison-Wesley; 1 edition (October 18, 2002)

PHY-423: General Theory of Relativity 3 Cr. Hrs

Objectives

- The students will be familiarized with the fundamental principles of the theory of relativity.
- They will know the meaning of the concept "inertial frame" and how gravity is understood in the theory of relativity.
- The student will be familiarized with the fundamental concepts and main contents of the theory of relativity: The principle of relativity, the kinematic- and the gravitational time dilation and frequency shift, curved spacetime, gravitational bending of light and relativistic universe models with expanding space.

The equivalence principle, Special Relativity, Rotating frames, Non-Inertial effects and Electromagnetism, Principle of General Covariance, Space-time as a differentiable manifold Vectors and vector fields, One-forms, Tensors, Differential forms, Hodge duality , Exterior derivative operator , Maxwell's equations and differential forms , Metric tensor, Absolute differentiation, Parallel transport, Autoparallel curves and geodesic, Geodesic coordinates, Symmetries of the Riemann tensor, Ricci tensor and curvature scalar, Curvature 2-form, Geodesic deviation and Bianchi identities, Einstein field equations, Schwarzschild solution, Time dependence and spherical symmetry, Gravitational red-shift, Geodesics in Schwarzschild space-time, Precession of planetary orbits, Deflection of light, Gravitational lenses, Radar echoes from planets, Radial motion in a Schwarzschild field, A gravitational clock effect , The interior Schwarzschild solution and the Tolman–Oppenheimer–Volkoff equation, Energy density and binding energy, Degenerate stars: white dwarfs and neutron stars, Schwarzschild orbits: Eddington–Finkelstein coordinates, Einstein–Rosen bridge and wormholes, Conformal treatment of infinity: Penrose diagrams, Rotating black holes: Kerr solution, The ergosphere and energy extraction from a black hole, Surface gravity,Thermodynamics of black holes and further observations, Global matters: singularities Trapped surfaces and Cosmic Censorship, Gravitational action and field equations , Energy-momentum pseudotensor, Kruskal–Szekeres coordinates, Weak field approximation, Radiation from a rotating binary source, Parallels between electrodynamics and General Relativity, Petrov classification.

Books Recommended:

- A First Course in General Relativity, Bernard F. Schutz, Cambridge University Press, 1985
- General Relativity, Robert M. Wald, University of Chicago Press, 2010
- Relativity: Special, General, and Cosmological, Wolfgang Rindler, OUP Oxford, 2006
- Gravitation and Spactime, Hans C. Ohanian, Remo Ruffini, Cambridge University Press, 2013
- Spacetime and Geometry: An Introduction to General Relativity, Sean M. Carroll, Prentice Hall, 2004
- Gravitation, Charles W. Misner, Kip S. Thorne, John Archibald Wheeler, W.H. Freeman and Company, 2002

PHY-402: Bio-Physics 3 Cr. Hrs

Objectives

- to explore the biophysics of signaling and movement at the cellular level
- to introduce mathematical modeling in biophysics
- to appreciate how biophysical measurements can be acquired and used in clinical environments
  to explore the applications of physical principles in medical physics

Motion and Bio-dynamics, Animal Locomotion, Simple Pendulum, Comparison of Pendulum and animal's legs and stepping time for an animal, Human legs as a Physical pendulum, the action of forces and torques, Waves and Bio-Optics, Wave phenomenon, Properties of sound waves and hearing, structure and function of the ear, the auditory canal and resonance in a closed /opened pipe , The middle Ear and the impedance matching between inner and outer ear, The inner Ear and resonance in Basilar fibers (Newton 2^{nd} law of motion), Optics in vision and eyesight correction, Properties of light refraction, reflection, Thin lenses and related concepts, Refractive power of lens, Optics of the eye and vision, Refractive power of the eye, visual acuity, Pupillary diameter effects, Eyesight problems and correction, Light Absorption and Color in Bio-molecules, Colors in biological tissues and natural pigments, Pigments and simple quantum mechanics, Electron resonance in a linear/cyclic conjugated molecules, Absorption and emission of light, Perception of colors and photoreceptors (cones), Absorption dependence on molecule length, Vibrational spectra, Electricity and Conduction in Human Body: Neurons and Nerve conduction, Electrical properties of Neurons, the concepts of resistance and voltage, Ohm's law, capacitance, interpretation of impulse propagation, Electric Potential and membrane Potential, electrical circuits and cardiovascular system, Action potential, Ohm's law, cable model of Axon, RC components and Axon membrane, Bio-Imaging: Protein structures, X-ray crystallography, and Bragg's law, Nuclear magnetic resonance (NMR) spectroscopy, Magnetic resonance imaging (MRI), Intrinsic magnetism and angular momentum effects, chemical shift and NMR Microscopy , Ultrasound imaging, Tomography or X-rays computed axial tomography (CAT or CT scan), Positron emission tomography (PET), Thermodynamics and the Origin of Life: Body temperature regulation, cellular metabolism, Living systems and first law of thermodynamics and energy conservation, Internal energy, Enthalpy, Life and 2^{nd} law of thermodynamic, Molecular entropy and disorder, Free energy of a system, Free energy and chemical equilibrium.

Books Recommended:

- Philip Nelson, Biological Physics: Energy, Information, Life, W.H. Freeman & Co., New York, 2004.
- Ronald Glaser, Biophysics, 5^{th} edition, Springer 2001

PHY-444: Materials Science 3 Cr. Hrs

Objectives

- Explain the differences in properties of different materials, including metals, alloys, ceramics, polymers and composites
- Relate the properties of materials to microstructure (quantitative skills)
- Discuss new fields of micro-electro-mechanical-systems (MEMS) and nanotechnology
- Describe the basics of processing techniques for altering the microstructure and properties of different materials
- Apply the basic principles of material selection to specific applications (critical thinking, quantitative skills)

Materials Science, Types of Materials, Structure-Property-Processing Relationship; Atomic Arrangement in Materials; Structural Imperfections, Atomic Movement; Physical and Mechanical, Behavior of Materials; Deformation, Cold Working, Work Hardening, Annealing, Hot Working; Phase Diagrams, Solidification, Cast structure; Phase Diagrams, Solid State Transformations; Heat Treatment; Material deterioration and its prevention; Failure of Materials; Ceramics, Polymers, Composites

Recommended Books:

- The Science and Engineering of Materials, by Donald R. Askeland, Pradeep P. Fulay, and Wendelin J. Wright (Cengage Learning, 2010).
- The Hand Book of Advanced Materials by James K. Wessel.
- Materials Science and Engineering by William D. Callister, Jr. and David G. Rethwisch.
- The Principles of Engineering Materials, C.R. Barrett, W.D. Nix, A.S. Tetelman, Prentice Hall, Upper Saddle River 1973.

PHY-443: Material Characterization Techniques 3 Cr. Hrs

Objectives

- Course Description:

This course work will provide basic descriptions of a range of common characterization methods for the determination of the structure and composition of solids. Special empesis is given to the techniques that are used to determine a variety of magnetic properties of bulk as well as nano structures and surfaces.

Sample preparation techniques: Physical methods, Sample preparation techniques: chemical methods, Absorption and Transmission Spectra, UV-Vis Spectrophotometer, FTIR, Atomic Force Microscopy (AFM), X-ray Diffraction (XRD), structure factor and intensity calculations, particle size calculation, Reciprocal lattice and Ewald sphere construction, Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), transmission electron microscopes, Thermogravimetric analysis (TGA), differential scanning calorimetry (DSC), Ultra-high-vacuum (UHV) chamber, preparation of ultra-thin magnetic films in UHV chamber, Ion Sputtering, Annealing, Auger Electron Spectroscopy (AES), Low Energy Electron Diffraction (LEED), LEED pattern to calculate lateral lattice constant, LEED-IV to find perpendicular lattice constant, Medium Energy Electron Diffration (MEED), X-rays and magnetism: X-ray Magnetic Linear Dichroism (XMLD), X-ray Magnetic Circular Dichroism (XMCD), Photo Emission Electron Microscope (PEEM), Scanning Tunneling Microscope (STM), Spin-Polarized STM, Vibrating Sample Magnetometry (VSM), Magnetic heating using AC mag. Field in Radio Frequency, Magneto-Optical Kerr Effect (MOKE), Electron Paramagnetic Resonance (EPR), Ferromagnetic Resonance (FMR), Nuclear Magnetic Resonance (NMR)

Books Recommended:

- B.D. Cullity, Elements of X-ray Diffraction (II edition), Addison-Wesley Publishing Co. Inc., Reading, USA, 1978.
- William F. Smith, Principles of Materials Science and Engineering, 2nd Ed., McGraw-Hill Publishing Company, USA, 1990
- Electron Microscopy: Principles And Fundamentals, S. Amelinckx, D. van Dyck, J. van Landuyt and G. van Tendeloo (Editors), VCH, Weinheim, 1997.
- Atomic Force Microscopy / Scanning Tunneling Microscopy, S.H. Cohen and Marcia L. Lightbody (Editors), Plenum Press, New York, 1994.
- Electron Microscopy and Analysis by P.J. Goodhew and F.J. Humphreys, Taylor and Francis, London, 1988
- Metallography: Principles and Practice by G.F. Vander Voort, ASM International, Materials Park, USA, 1984
- Principles of Thermal Analysis and Calorimetry by P.J. Haines

PHY-445: Nano-Physics and Technology 3 Cr. Hrs

Objectives

- How does one make a nanometer sized object?
- How do the magnetic, optical and electrical properties of this nanoscale object change with size?
- How do charges behave in nanoscale objects?
- How does charge transport occur in these materials?
- Do these nanoscale materials posess new and previously undiscovered properties?
- How are they useful?
- The student shall learn how basic physics can be used to describe and understand the behavior of electrons in nano-scale materials.
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Introduction to nanophysics and nanotechnology, What is nanoscience?, There's plenty of rooms at the bottom- A lecture by Feynman on nano structures in 1957, Why Physics is different for small systems?, Quantum nature of nanoworld, Microscopy and manipulation tools, Making nanostructures: top-down, Making nanostructures: bottom-up, Electrons in nanostructures, Molecular electronics, Nanostructured materials, Nanobiology, Microscscaling laws and limits to smallness, nano fabrication, nanoscopy, Properties and application of semiconductor nanostructures, fabrication of semiconductor nanowires and quantum dots, electronic and optical properties, optical spectroscopy of semiconductor nanostructures, carbon nanostructures, nanomagnets and nanomagnetism, Paramagnetism, Langevin theory of Paramagnetism, Ferro-magnetism, Weiss theory of Ferromagnetism (Spontaneous magnetization), Magnetic Domains, Types of magnetic domains, Magnetic relaxation and resonance phenomena. Growth of Organised Nano-Objects on Prepatterned Surfaces, Clusters and Colloids, Fullerenes and Carbon Nanotubes, Nanowire, Nano-Object, Ultimate Electronics, Molecular Electronics, Nanomagnetism and Spin Electronics, Information Storag, Optronics, Nanophotonics for Biology, Numerical Simulation, Computer Architectures for Nanotechnology: Towards Nanocomputing.

Books Recommended:

- Nanoscience Nanotechnologies and Nanophysics, C. Dupas P. Houdy M. Lahmani (Eds.), Springer-Verlag, Berlin Heidelberg, Germany, 2007.
- Introduction to Nanoscience, S. N. Lindsay, Oxford University Press, 2008
- Nanoscale Science and Technology, Eds. R. W. Kelsall, I. W. Hamley and M. Geoghegan, John Wiley & Sons (2005)
- Edward L. Wolf, Nanophysics and nanotechnology: An Introduction to Modern Concepts in Nanoscience, Wiley-VCH (2006)
- Ch. Poole Jr., F. J. Owens, Introduction to nanotechnology, John Wiley & Sons, Inc., 2003.
- Marius Grundmann, The Physics of Semiconductors-An Introduction including Devices and nanophysics, Springer-Verlag, Berlin Heidelberg, Germany, 2006.

PHY-482: Astro-Physics 3 Cr. Hrs

Objectives

- Describe the features of objects in the Solar System (i.e. Sun, planets, moons, asteroids, comets, planetary interiors, atmospheres, etc.) giving details of similarities and differences between these objects;

- Demonstrate an understanding of the basic properties of the Sun and other stars;

- Explain stellar evolution, including red giants, supernovas, neutron stars, pulsars, white dwarfs and black holes, using evidence and presently accepted theories;
- Explain the evolution of the expanding Universe using concepts of the Big Bang and observational evidence;

- Use information learned in class and develop observation skills to be able to explain astronomical features and observations obtained via telescopic observations or data provided through computer simulations.

Introduction and overview, Telescopes, Detectors, Instruments, satellites, Matter and Radiation, Interstellar medium, collapse of gas clouds, Jeans criterion, Star formation and Stellar structure, Nuclear reactions, Hydrostatic equilibrium, virial theorem, Stars masses, lStellar atmospheres, energy transport via radiation and convection, atomic transitions, chemical abundances, Properties of Stars and their spectra, Stellar dynamics, Evolution and final stages, Phenomenology of stars, magnitudes, colors, spectra, distances, radii, temperatures and luminosities, binaries, Gravitational, thermal, nuclear time scales. Ages of star, Metallicities, Evolution on the Main Sequence, Stellar evolution beyond the main sequence, AGB stars, HR Diagram, Binary Stars and Accretion Processes, Fate of Massive Stars, Supernova, types of supernova, Degenerate matter, stellar remnants, white dwarfs, Brown Dwarf, Neutron stars and black holes, pulsars, gamma-ray bursts, Planetary Nebulae, , X-ray binaries

Recommended books:

- An Introduction to Modern Stellar Astrophysics, D.A. Ostlie, B.W. Carrol, Addison-Wisley Publishing Company, Inc., 1996.
- Nucleosynthesis and Chemical Evolution of Galaxies, B.E.J. Pagel, Cambridge Uni. Press, 1997.

PHY-483: Physics of Laser Plasma Interaction 3 Cr. Hrs

Objectives

- To analyze the electromagnetic wave propagation in plasma
- To understand the basics of laser plasma interaction under physical conditions
- To understand various plasma instabilities under different plasma configurations

The basic concepts and two-fluid descriptions of plasmas, EM wave propagation in plasmas, propagation of obliquely incident light waves in inhomogeneous plasmas, collisional absorption of EM waves, Parametric excitation of electron and ion waves. Stimulated Raman and Brillouin scattering, heating by plasma waves, density-profile modification,The nonlinear features of underdense plasma instabilities, electron energy transport, Laser plasma experiments, Physics of laser plasma interaction.

Recommended Books:

- Lasers and Electro-Optics by Christopher Davis, 2nd edition, Cambridge University Press; 2 edition (May 12, 2014)
- WL Kruer, Physics Of Laser Plasma Interactions- Westview Press (2003)
- J.J.Duderstadt & G.A.Mosses, Inertial Confinement Fusion (John-Wiley and Sons) 1982.
- Akira Hasegawa, Plasma Instablities and Nonlinear Effects (Spring-Verlag) 1975.

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