Syllabus of BS in Physics

Effective for the Academic Session 2022 onward

B.S- Physics Syllabus

Programme: BS in Physics
Duration: 4 years
Number of semesters: 8
Number of weeks per semester: 16-18 (2 weeks for examinations)
Total number of credit hours: 133
Number of credit hours per semester: 15-18
Eligibility Criteria for Admission:
FSc Pre-Engineering/A-Level Cambridge (with Maths and Physics) / Three year polytechnic degree

Semester 1

Course Code	Course Title	Credit Hours
PHY-601	Mechanics-I	4 (3 – 1)
MATH-601	Calculus-I	3 (3 – 0)
CS-601	Introduction to Computer	3 (3 – 0)
ISL-601	Islamic Studies / Ethics	2 (2 – 0)
ENG-601	English-I (Functional English and Grammar)	3 (3 – 0)
Total		**15**

Semester 2

Course Code	Course Title	Credit Hours
PHY-602	Electricity & Magnetism	4 (3 – 1)
PHY-603	Heat & Thermodynamics	3 (3 – 0)
STAT-601	Introduction to Statistics and Probability	3 (3 – 0)
MATH-602	Calculus-II	3 (3 – 0)
PST-601	Pakistan Studies	2 (2 – 0)
ENG-602	English-II (Technical Writing)	3 (3 – 0)
Total		**18**

Semester 3

Course Code	Course Title	Credit Hours
PHY-604	Waves and Oscillation	4 (3 – 1)
PHY-605	Modern Physics-I	3 (3 – 0)
MATH-603	Linear Algebra	3 (3 – 0)
PHY-606	Properties of Matter	4(3 – 1)
ENG-603	English - III (Communication Skills)	3 (3 – 0)
Total		**17**

Semester 4

Course Code	Course Title	Credit Hours
PHY-607	Circuit Theory	4 (3 – 1)
PHY-608	Optics	3 (3 – 0)
MATH-604	Differential Equations	3 (3 – 0)
PHY-609	Modern Physics-II	4 (3 -1)
CHEM-601	Applied Chemistry	3 (3 – 0)
Total		**17**

Semester 5

Course Code	Course Title	Credit Hours
PHY-610	Mathematical Methods of Physics-I	3 (3 – 0)
PHY-611	Classical Mechanics	3 (3 – 0)
PHY-612	Solid State Physics-I	3(3 – 0)
PHY-613	Electronics-I	4 (3 – 1)
PHY-614	Electromagnetic Theory-I	3 (3 – 0)
Total		**16**

Semester 6

Course Code	Course Title	Credit Hours
PHY-615	Mathematical Methods of Physics-II	3 (3 – 0)
PHY-616	Thermal & Statistical Mechanics	3 (3 – 0)
PHY-617	Solid State Physics-II	4 (3 – 1)
PHY-618	Electromagnetic Theory-II	3 (3 – 0)
PHY-619	Electronics-II	4 (3 – 1)
Total		**17**

Semester 7

Course Code	Course Title	Credit Hours
PHY-620	Quantum Mechanics-I	3 (3 – 0)
PHY-621	Atomic and Molecular Physics	3 (3 – 0)
PHY-622	Nuclear Physics	4 (3 – 1)
PHY-623	Computational Physics-I	3 (3 – 0)
PHY-627	Digital Electronics	4 (3 - 1)
Total		**17**

Semester 8

Course Code	Course Title	Credit Hours
PHY-624	Quantum Mechanics-II	3 (3 – 0)
PHY-625	Computational Physics-II	3 (3 – 0)
PHY-626	Project and Thesis: (The Project and Thesis should start from 7^{th} semester. The 1) workshop of research methodology, 2) topic selection, 3) introduction, and 4) Literature review should be completed in 7^{th} semester. The final defense of thesis will be in 8^{th} semester)	6(6-0)
PHY-627	Optional Paper	4 (3 – 1)
Total		**16**

Optional Subjects in 8th Semester

PHY-628	Environmental Physics	4 (3 – 1)
PHY-629	Nanoscience and Nanotechnology	4 (3 – 1)
PHY-630	Communication System	4 (3 – 1)
PHY-631	Renewable Energy	4 (3 – 1)
PHY-632	Applied Solid State Physics	4 (3 – 1)
PHY-633	Radiation Safety and Nuclear Reactor Design	4 (3 – 1)
PHY-634	Mechatronics	4 (3 – 1)
PHY-635	Microprocessors and microcontrollers	4 (3 – 1)

Total Credit Hours: 133

One optional subject of 4 credit hours to be taken in Semester 8. Project and Thesis will be allocated in the 7th semester. However, the credit hours for thesis will only be counted in the 8th semester. Internship will be offered to students during vacations as an optional activity.

PHY-601 MECHANICS: Credit Hours: 4(3-1)

Objectives:

The main objective of this course is to understand the different motions of objects on a macroscopic scale and to develop simple mathematical formalisms to analyze such motions. This is a calculus-based introductory course with maximum emphasis on applying the acquired knowledge to solving problems.

Basic Concepts: Scalars and Vectors, Multiplication of Vectors: Dot and Cross Products. Vector triple product, scalar triple product, Del Operator, Divergence theorem, stokes theorem, Coordinate systems: Cartesian system, spherical, cylindrical system of coordinates.

Motion in One, Two and Three Dimensions: Position & Displacement, Velocity and Acceleration, Motion under Constant Acceleration, Projectile Motion, Uniform Circular Motion, Relative Velocity and Acceleration in One and Two Dimensions, Inertial and Non-Inertial Reference Frames.

Newton's Laws: Newton's Laws of Motion and their Applications involving some particular forces including Weight, Normal Force, Tension, Friction, and Centripetal Force, Newton's Law of Gravitation, Gravitational Potential Energy, Escape Velocity, Kepler's Laws, Satellite Orbits & Energy.

Work and Kinetic Energy: Work done by Constant and Variable Forces: Gravitational and Spring Forces, Power, Conservative and Non-conservative Forces, Work and Potential Energy, Isolated

Systems and Conservation of Mechanical Energy, Work Done by External Forces including Friction and Conservation of Energy.

System of Particles: Motion of a System of Particles and Extended Rigid Bodies, Center of Mass and Newton's Laws for a System of Particles, Linear Momentum, Impulse, Momentum & Kinetic Energy in One and Two Dimensional Elastic and Inelastic Collisions.

Rotational Motion: Rotation about a Fixed Axis, Angular Position, Angular Displacement, Angular Velocity and Angular Acceleration, Rotation under Constant Angular Acceleration, relationship between Linear and Angular Variables, Rotational Inertia, Parallel-axis Theorem, Torque and Newton's Law for Rotation, Work and Rotational Kinetic Energy, Power, Rolling Motion, Angular Momentum for a single Particle and a System of Particles,

Conservation of Angular Momentum, Precession of a Gyroscope, Static Equilibrium involving Forces and Torques, Determination of moment of inertia of various shapes i.e. for disc, bar and solid sphere.

Angular Momentum: Angular Velocity, Conservation of angular momentum, effects of Torque and its relation with angular momentum.

Simple Harmonic Motion (SHM): Amplitude, Phase, Angular Frequency,

Velocity and Acceleration in SHM, Linear and Angular Simple Harmonic Oscillators, Energy in SHM, Simple Pendulum, Physical Pendulum, SHM and Uniform Circular Motion, Damped Harmonic Oscillator.

PRACTICALS:

1. To determine the value of "g" by simple pendulum.
2. To determine the value of "g" by compound pendulum/ Kater's Pendulum.
3. To study the damping features of an oscillating system using simple pendulum of variable mass.
4. To study the dependence of Centripetal force on mass, radius, and angular velocity of a body in circular motion.
5. Determination of moment of inertia of a solid/hollow cylinder and a sphere etc

Recommended Books:

1. D. Halliday, R. Resnick and J. Walker, "Fundamentals of Physics", John Wiley & Sons, 9th ed. 2010.

2. R. A. Serway and J. W. Jewett, "Physics for Scientists and Engineers", Golden Sunburst Series, 8th ed. 2010.

3. R. A. Freedman, H. D. Young, and A. L. Ford (Sears and Zeemansky), "University Physics with Modern Physics", Addison-Wesley-Longman, 13th International ed. 2010.

4. F. J Keller, W. E. Gettys and M. J. Skove, "Physics: Classical and Modern, McGraw Hill. 2nd ed. 1992.

5. D. C. Giancoli, "Physics for Scientists and Engineers, with Modern Physics", Addison-Wesley, 4th ed. 2008.

MATH-601 CALCULUS- I Credit Hours: 3(3-0)

Prerequisites: Knowledge of Intermediate Calculus

Specific Objectives of course: Calculus serves as the foundation of advanced subjects in all areas of mathematics. This is the first course of Calculus. The objective of this course is to introduce students to the fundamental concepts of limit, continuity, differential and integral calculus of functions of one variable.

Course Outline: Equations and inequalities: Solving linear and quadratic equations, linear inequalities. Division of polynomials, synthetic division. Roots of a polynomial, rational root;

Viete Relations. Descartes rule of signs. Solutions of equations with absolute value sign. Solution of linear and non-linear inequalities with absolute value sign. Functions and graphs: Domain and range of a function. Examples: polynomial, rational, piecewise defined functions, absolute value functions, and evaluation of such functions. Operations with functions: sum, product, quotient and composition. Graphs of functions: linear, quadratic, piecewise defined functions. Lines and systems of equations: Equation of a straight line, slope and intercept of a line, parallel and perpendicular lines. Systems of linear equations, solution of system of linear equations. Nonlinear systems: at least one quadratic equation. Limits and continuity: Functions, limit of a function. Graphical approach. Properties of limits. Theorems of limits. Limits of polynomials, rational and transcendental functions. Limits at infinity, infinite limits, one-sided limits. Continuity.

Derivatives: Definition, techniques of differentiation. Derivatives of polynomials and rational, exponential, logarithmic and trigonometric functions. The chain rule. Implicit differentiation. Rates of change in natural and social sciences. Related rates. Linear approximations and differentials. Higher derivatives, Leibnitz's theorem. Applications of derivatives: Increasing and decreasing functions. Relative extrema and optimization. First derivative test for relative extrema. Convexity and point of inflection. The second derivative test for extrema. Curve sketching. Mean value theorems. Indeterminate forms and L'Hopitals rule. Inverse functions and their derivatives. Integration: Anti derivatives and integrals. Riemann sums and the definite integral. Properties of Integral. The fundamental theorem of calculus. The substitution rule.

Recommended Books:

1. Thomas, Calculus, 11th Edition. Addison Wesley Publishing Company, 2005
2. H. Anton, I. Bevens, S. Davis, Calculus, 8th Edition, JohnWiley & Sons, Inc. 2005
3. Hughes-Hallett, Gleason, McCallum, et al, Calculus Single and Multivariable, 3rd Edition. John Wiley & Sons, Inc. 2002.
4. Frank A. Jr, Elliott Mendelson, Calculus, Schaum's outlines series, 4th Edition, 1999
5. C.H. Edward and E.D Penney, Calculus and Analytics Geometry, Prentice Hall, Inc. 1988
6. E. W. Swokowski, Calculus with Analytic Geometry, PWS Publishers, Boston, Massachusetts, 1983.
7. M. Liebeck, A Concise introduction to pure Mathematics, CRC Press, 2011.
8. A. Kaseberg, Intermediate Algebra, Thomson Brooks/cole, 2004.

CS-601 INTRODUCTION TO COMPUTER Credit Hours: Credit Hours: 3(3-0)

Course objectives:

To develop understanding of basics of computer components, their operations, algorithm development techniques and basic programming.

Essential topics to be covered:

- Introduction to computer components and operating systems
- Number systems
- Problems solving techniques: flow chart and algorithm development
- Computer programming fundamentals

Course description:

Introduction to numbers systems, CPU, memory, input/output devices, data organization, file storage, programs and software, system and application software, operating systems, communication technology, Compiler, DBMS, Computer networks and internet, WWW, web mail applications, Computer graphics, AI, Viruses and Anti-Viruses.

programming languages, compilation and interpretation, problem specification, algorithms, flow chart, pseudo code, basic programming techniques, data types and declaration, header file and linkage, variables and constants, arrays, input/output, termination, remark, control structures, Branching, conditional structures, repetition and loops, basic library functions,

Recommended books:

1. Computer science-An Overview by Glenn Brookshear, 3rd edition
2. Computer Science Illuminated by Nell Dale and John Lewis, 2nd edition

ISL-601 ISLAMIC STUDIES Credit Hours: Credit Hours: 2(2-0)

OBJECTIVES

To provide Basic information about Islamic Studies, Islamic Civilization, prayers and other worships and issues related to faith and religious life.

CONTENTS

Introduction to Quranic Studies: Basic Concepts of Quran**,** History of Quran**,** Uloom-ul-Quran, Study of Selected Text of Holly Quran:

Verses of Surah Al-Baqara Related to Faith(Verse No-284-286)**,**Verses of Surah Al-Hujrat Related to Adab Al-Nabi(Verse No-1-18), Verses of Surah Al-Mumanoon Related to Characteristics of faithful (Verse No-1-11),Verses of Surah al-Furqan Related to Social Ethics (Verse No.63-77),Verses of Surah Al-Inam Related to Ihkam (Verse No-152-154),

Study of Selected Text of Holly Quran: Verses of Surah Al-Ihzab Related to Adab al-Nabi (Verse No.6, 21, 40, 56, 57, 58.),Verses of Surah Al-Hashar (18,19,20) Related to thinking, Day of Judgment,Verses of Surah Al-Saf Related to Tafakar, Tadabar (Verse No-1,14)

Seerat of Holy Prophet (S.A.W): Life of Muhammad Bin Abdullah (Before Prophet Hood), Life of Holy Prophet (S.A.W) in Makkah, Important Lessons Derived from the life of Holy Prophet in Makkah, Seerat of Holy Prophet (S.A.W) II:Life of Holy Prophet (S.A.W) in Madina, Important Events of Life Holy Prophet in Madina, Important Lessons Derived from the life of Holy Prophet in Madina.

Introduction to Sunnah: Basic Concepts of Hadith, History of Hadith, Kinds of Hadith, Uloom –ul-Hadith, Sunnah & Hadith, Legal Position of Sunnah, Introduction to Islamic Law & Jurisprudence: Basic Concepts of Islamic Law & Jurisprudence, History & Importance of Islamic Law & Jurisprudence, Sources of Islamic Law & Jurisprudence, Nature of Differences in Islamic Law, Islam and Sectarianism, Islamic Culture & Civilization: Basic Concepts of Islamic Culture & Civilization, Historical Development of Islamic Culture & Civilization, Characteristics of Islamic Culture & Civilization, Islamic Culture & Civilization and Contemporary Issues,

Islam & Science: Basic Concepts of Islam & Science, Contributions of Muslims in the Development of Science, Quran & Science. Islamic Economic System: Basic Concepts of Islamic Economic System, Means of Distribution of wealth in Islamic Economics, Islamic Concept of Riba,

Islamic Ways of Trade & Commerce, Political System of Islam: Basic Concepts of Islamic Political System, Islamic Concept of Sovereignty, Basic Institutions of Govt. in Islam,

Islamic History: Period of Khlaft-E-Rashida, Period of Ummayyads,Period of Abbasids,

Social System of Islam: Basic Concepts of Social System of Islam,Elements of Family,Ethical Values of Islam

BOOKS RECOMMENDED

1. Hameed ullah Muhammad. Emergence of Islam, IRI,Islamabad
2. Hameed ullah Muhammad. Muslim Conduct of State
3. Hameed ullah Muhammad. Introduction to Islam
4. Hussain Hamid Hassan. An Introduction to the Study of Islamic Law, leaf Publication Islamabad, Pakistan.
5. Ahmad Hasan. Principles of Islamic Jurisprudence, Islamic Research
1. Institute, International Islamic University, Islamabad
6. Mir Waliullah. Muslim Jurisprudence and the Quranic Law of Crimes, Islamic Book Service
7. H. S. Bhatia. Studies in Islamic Law, Religion and Society, Deep & Deep Publications New Delhi
8. Dr. Muhammad Zia-ul-Haq. Introduction to Al Sharia Al Islamia, Alama Iqbal Open University, Islamabad

ISL-601 ETHICS for NON-MUSLIMS Credit Hours: 2(2-0)

نصاب بی اے اخلاقیات (غیر مسلم طلباء کے لیے)

Syllabus of B.A.Ethics (for Non Muslim)

۱۔ تعریف اخلاق، علم الاخلاق کا دیگر علوم سے تعلق (علم الاخلاق اور نفسیات، علم الاخلاق اور عمرانیات، علم الاخلاق اور سیاسیات، علم الاخلاق اور قانون)

۲۔ اسلام کا فلسفہ اخلاق، اسلام میں اخلاق کی اہمیت، فضائل اخلاق (صدق، سخاوت، عفت و پاکیزگی، دیانتداری، عدل وانصاف، عہد کی پابندی، احسان، عفو و درگذر) اخلاق ذمیمہ (جھوٹ، خیانت، غداری، چوری، رشوت، ظلم)

۳۔ عیسائیت کی اخلاقی تعلیمات، عقیدہ تثلیث، عقیدہ کفارہ، عقیدہ مصلوبیت، بپتسمہ، عشائے ربانی، اناجیل اربعہ۔

۴۔ ہندومت کی اخلاقی تعلیمات، عقیدہ تری مورتی، آواگون، ذات پات، مذہبی کتب۔

۵۔ گرونانک کی حیات وخدمات، تصور معبود، تصور عبادت، خالصہ اور ان کے پانچ کاف۔

۶۔ گوتم بدھ کے حالات زندگی اور اخلاقی تعلیمات، بھکشو بننے کے لیے شرائط، ہشت پہلو۔

مطالعاتی کتب:

(۱) سید سلیمان ندوی	سیرت النبی (جلد ششم)	(۲) حفظ الرحمٰن سیوہاروی	اخلاق وفلسفہ اخلاق
(۳) سی اے قادر	اخلاقیات	(۴) خورشید احمد	اسلامی نظریہ حیات
(۵) مولنا مودودی	اسلام کا اخلاقی نقطہ نظر	(۶) امام غزالی	اسلامی آداب واخلاق
(۷) عبدالعلی اچکزئی	روضۃ الاسلام	(۸) عبدالعلی اچکزئی	روضہ علوم اسلامیہ (۲)
(۹) عبدالرشید	ادیان ومذاہب کا تقابلی مطالعہ	(۱۰) غلام رسول چیمہ	مذاہب عالم کا تقابلی مطالعہ

ENG-601 FUNCTIONAL ENGLISH AND GRAMMER Credit Hours: Credit Hours: 3(3-0)

Title of Course. English I (Functional English)

Objectives: Enhance language skills and develop critical thinking.

Course Contents

Basics of Grammar

Parts of speech and use of articles, Sentence structure, active and passive voice, Practice in unified sentence, Analysis of phrase, clause and sentence structure, Transitive and intransitive verbs, Punctuation and spelling

Comprehension

Answers to questions on a given text

Discussion

General topics and every-day conversation (topics for discussion to be at the discretion of the teacher keeping in view the level of students)

Listening

To be improved by showing documentaries/films carefully selected by subject teachers

Translation skills

Urdu to English

Paragraph writing

Topics to be chosen at the discretion of the teacher

Presentation skills

Introduction

Note: Extensive reading is required for vocabulary building

RECOMMENDED BOOKS:

a) Grammar

1. Thomson, A. J., & Martinet, A.V., (1997) Practical English Grammar, Exercises 1, Third edition. Oxford University Press, Oxford, ISBN 0194313492
2. Thomson, A. J., & Martinet, A.V.,(1997) Practical English Grammar, Exercises 2, Third edition, Oxford University Press, ISBN 0194313506

b) Writing

1. Boutin, M. C., Brinand, S. & Grellet, F., (1993) Writing. Intermediate, Oxford Supplementary Skills, Fourth Impression, ISBN 0 19 435405 7 Pages 20-27 and 35-41.

c) Reading/Comprehension

1. Tomlinson, B. & Ellis, R. (1992) Upper Intermediate, Oxford Supplementary Skills. Third Impression, ISBN 0 19 453402 2.

PHY-602-ELECTRICITY AND MAGNETISM Credit Hours: 4(3-1)

Pre-requisite: Mechanics, Calculus I

Co-requisite: Calculus II

Objectives:

The main objective of this course is to understand the Physics of Electromagnetism and to develop simple mathematical formalisms to analyze the electromagnetic fields and interactions. This is a calculus-based introductory course with maximum emphasis on applying the acquired knowledge to solving problems.

Electrostatics: Electric Charge, , Conductors and Insulators, Coulomb's Law, Electric Fields due to a Point Charge and an Electric Dipole, Electric Field due to different Charge Distribution (line, disc,

ring), Electric Dipole in an Electric Field, Electric Flux, Gauss' Law and its Applications in Planar, Spherical and Cylindrical Symmetry.

Electric Potential: Electric potential, Electric potential energy**,** Equipotential Surfaces, Potential due to a Point Charge and a Group of Point Charges, Potential due to an Electric Dipole, Potential due to a Charge Distribution, Relation between Electric Field and Electric Potential.

Magnetic Field and Magnetic Force: Crossed Electric and Magnetic Fields and their Applications, Hall Effect, Magnetic Force on a Current Carrying Wire, Torque on a Current Loop, Magnetic Dipole Moment, Magnetic Field Due to a Current, Force between two Parallel Currents, Ampere's Law, Biot- Savart Law: Magnetic Field due to a Current, Long Straight Wire carrying Current, Solenoids and Toroids, A current-carrying Coil as a Magnetic Dipole,

Electro Magnetic Induction: Inductance, Faraday's Law of Induction, Lenz's Law, Induction and Energy Transfers, Induced Electric Fields, Inductors and Inductances, Self Inductance, RL Circuits, Energy Stored in a Magnetic Field, Energy Density, Mutual Induction.

Alternating Fields and Currents: LC Oscillations, Damped Oscillations in an RLC circuit, Alternating Currents, Forced Oscillations, Resistive, Capacitive, and Inductive Loads, RLC series Circuit, Power in AC Circuits, Transformers, Gauss' Law for Magnetism, Induced Magnetic Fields, Displacement Current, Spin & Orbital Magnetic Dipole Moment, Diamagnetism, Paramagnetism, Ferromagnetism, Hysteresis.

Practicals:

1. Measurement of high resistance using a neon flash bulb and a capacitor.
2. Measurement of low resistance coil by a Cary Foster Bridge.
3. Conversion of a moving-coil galvanometer into voltmeter.
4. Conversion of a moving-coil galvanometer into ammeter.
5. Calibration of an ammeter using a potentiometer.
6. Calibration of a voltmeter using a potentiometer.
7. Charge sensitivity of a ballistic galvanometer.
8. Comparison of capacities of two capacitors by a ballistic galvanometer.
9. To determine the self inductance of a coil by Rayleigh's Method.
10. To determine the self inductance of a coil by Anderson's Method.
11. To determine the coefficient of mutual inductance of a pair of a coils.

Recommended Text Books:

1. D. Halliday, R. Resnick and J. Walker, "Fundamentals of Physics", John Wiley & Sons, 9th ed. 2010.
2. R. A. Serway and J. W. Jewett, "Physics for Scientists and Engineers", Golden Sunburst Series, 8th ed. 2010.
3. R. A. Freedman, H. D. Young, and A. L. Ford (Sears and Zeemansky), "University Physics with Modern Physics", Addison-Wesley-Longman, 13th International ed. 2010.
4. F. J Keller, W. E. Gettys and M. J. Skove, "Physics: Classical and Modern, McGraw Hill. 2nd ed. 1992.
5. D. C. Giancoli, "Physics for Scientists and Engineers, with Modern Physics", Addison-Wesley, 4th ed. 2008.

PHY-603-HEAT AND THERMODYNAMICS Credit Hours: : 3(3-0)

Pre-requisites: Mechanics

Co-requisites: Calculus-II

Objectives: To understand the fundamentals of heat and thermodynamics.

Basic Concepts and Definitions in Thermodynamics: Thermodynamic system, Surrounding and Boundaries. Type of systems. Macroscopic and microscopic description of system. Properties and state of the substance: Extensive and Intensive properties, Equilibrium, Mechanical and Thermal Equilibrium. Processes and Cycles: Isothermal, Isobaric and Isochoric. Zeroth Law of Thermodynamics, Consequence of Zeroth law of Thermodynamics. The state of the system at Equilibrium.

Heat and Temperature: Temperature, Kinetic theory of ideal gas, Work done on an ideal gas, Review of previous concepts. Internal energy of an ideal gas: Equipartition of Energy, Intermolecular forces, Qualitative discussion, The Virial expansion, The Van der Waals equation of state.

Thermodynamics: First law of thermodynamics and its applications to adiabatic, isothermal, cyclic and free expansion. Reversible and irreversible processes. Second law of thermodynamics, Carnot theorem and Carnot engine. Heat engine, Refrigerators. Calculation of efficiency of heat engines. Thermodynamic temperature scale: Absolute zero, Entropy, Entropy in reversible process, Entropy in irreversible process. Entropy and Second law of thermodynamics, Entropy and Probability. Thermodynamic Functions: Thermodynamic functions (Internal energy, Enthalpy, Gibb's functions, Entropy, Helmholtz functions), Maxwell's relations, TdS equations, Energy equations and their applications. Low Temperature Physics, Joule-Thomson effect and its equations. Thermoelectricity: Thermocouple, Seabeck's effect, Peltier's effect,

Recommended Books:

1. D. Halliday, R. Resnick and K. Krane, "Physics", John Wiley, 5th ed.2002.
2. D. Halliday, R. Resnick and J. Walker, "Fundamentals of Physics", John Wiley, 9th ed. 2010.
3. M. W. Zemansky, "Heat and Thermodynamics", Mc Graw Hill, 7th ed.1997.
4. M. Sprackling, "Thermal Physics" McMillan 1991.
5. B. N. Roy, "Principle of Modern Thermodynamics", Institute of Physics,London 1995.

STAT- 601 INTRODUCTIONS TO STATISTICS AND PROBABILITY Credit Hours: 3(3-0)

Introductory Statistics.

The nature and scope of the Statistics, Variables and their types, Data and its sources, Scales of measurements, Tabulation and classification of data, Graphs and Charts: Stem-and leaf diagram, Box and Whisker plots and their interpretation. Measures of Central Tendency, Quantiles, Meaures of Dispersion: Their properties, usage, limitations and comparison. Moments, Measures of Skewness and Kurtosis and Distribution shapes. Rates and ratios, Standardized scores.

Introduction to Probability & Probability

Distributions, Probability Concepts, Addition and Multiplication rules, bivariate frequency, tables, joint and marginal probabilities, Conditional probability and independence, Bayes' rule, Random Variables, Discrete Probability Distribution, Mean and Variance of a discrete random variable, Bernoulli trials, Properties, applications and fitting of Binomial, Poisson, Hypergeometric, Negative Binomial and Geometric distributions Continuous Random Variable, probability density function and its properties, Normal Distribution and its properties, Standard Normal Curve.

RECOMMENDED BOOKS

1. A basic course in statistics / G.M. Clarke, D. Cooke. Edition: 5th ed. Publisher: London : John Wiley, 2004
2. Chaudhry, S.M.and Kamal, S. (2008), "Introduction to Statistical Theory" Parts I & II, 8th ed, Ilmi Kitab Khana, Lahore, Pakistan.
3. Mann, P. S. (2010) Introductory Statistics. Wiley. 4. Mclave, J.T.,Benson, P.G. and Snitch, T. (2005) "Statistics for Business & Economics" 9th ed. Prentice Hall, New Jersey.
4. Schaum's outline of theory and problems of beginning statistics / Larry J. Stephens. Edition: 2nd ed. Publisher: New York : McGraw- Hill, 2006
5. Spiegel, M.R., Schiller, J.L. and Sirinivasan, R.L. (2000) "Probability and Statistics", 2nd ed. Schaums Outlines Series. McGraw Hill. NY.
6. Sullivan, M., Fundamentals of statistics, III. Edition: 3rd ed. Publisher: Boston: Prentice Hall, 2011.
7. Walpole, R.E., Myers, R.H and Myers, S.L. (2007), "Probability and Statistics for Engineers and Scientist" 7th edition, Prentice Hall, NY.
8. Weiss, N.A.(1997), "Introductory Statistics" 4th ed. Addison-Wesley Pub. Company, Inc.
9. Cacoullos, T., Exercises in probability, Publisher: New York: Springer- Verlag, 2009
10. Clark, G.M. and Cooke, D. (1998), "A Basic Course in Statistics" 4th ed, Arnold, London.
11. Mclave, J.T., Benson, P.G. and Snitch, T. (2005) "Statistics for Business & Economics" 9th Edition. Prentice Hall, New Jersey.
12. Santos.D., Probability: an introduction, Publisher: Sudbury, Mass Jones and Bartlett Publishers, 2011.

MATH- 602 CALCULUS –II (Credit Hours: : 3(3-0)

Prerequisites: Calculus I

Specific Objectives of course: This is second course of Calculus. As continuation of Calculus I, it focuses on techniques of integration and applications of integrals. The course also aims at introducing the students to infinite series, parametric curves and polar coordinates.

Course Outline:

Techniques of integration: Integrals of elementary, hyperbolic, trigonometric, logarithmic and exponential functions. Integration by parts, substitution and partial fractions. Approximate integration. Improper integrals.

Applications of integrals: Area under and between curves, Area between lines, area between the line and curve, average value. Volumes. Arc length. Area of a surface of revolution. Applications to Economics, Physics, Engineering and Biology.

Power series. Convergence of power series. Representation of functions as power series. Differentiation and integration of power series. Taylor and McLaurin series. Approximations by Taylor polynomials.

Conic section: parameterized curves and polar coordinates: Curves defined by parametric equations. Calculus with parametric curves: tangents, areas, arc length. Polar coordinates. Polar curves, tangents to polar curves. Areas and arc length in polar coordinates.

Recommended Books:

1. Thomas, Calculus, 11th Edition. Addison WesleyPublishing Company, 2005
2. H. Anton, I. Bevens, S. Davis, Calculus, 8th Edition, John Wiley & Sons, Inc. 2005
3. Hughes-Hallett, Gleason, McCallum, et al, Calculus Single and Multivariable, 3rd Edition. John Wiley & Sons, Inc. 2002.

4. Frank A. Jr, Elliott Mendelson, Calculus, Schaum's outlines series, 4th Edition, 1999
5. C.H. Edward and E.D Penney, Calculus and Analytics Geometry, Prentice Hall, Inc. 1988
6. E. W. Swokowski, Calculus with Analytic Geometry, PWS Publishers, Boston, Massachusetts, 1983.
7. M. Liebeck, A Concise introduction to pure Mathematics, CRC Press, 2011.
8. A. Kaseberg, Intermediate Algebra, Thomson Brooks/COLE, 2004.
9. J. Stewart, Calculus early transcendentals, 7th Edition, Brooks/COLE, 2008.

PST- 601 PAKISTAN STUDIES Credit Hours: : 2(2-0)

Title of Course.Pakistan Studies (Compulsory)

Introduction/Objectives

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.

Course Outline

1. **Historical Perspective**

a. Ideological rationale with special reference to Sir Syed Ahmed Khan, Allama Muhammad Iqbal and Quaid-e-Azam Muhammad Ali Jinnah.
b. Factors leading to Muslim separatism
c. People and Land
i. Indus Civilization
ii. Muslim advent
iii. Location and geo-physical features.

2. **Government and Politics in Pakistan**

Political and constitutional phases:
a. 1947-58
b. 1958-71
c. 1971-77
d. 1977-88
e. 1988-99
f. 1999 onward

3. **Contemporary Pakistan**

a. Economic institutions and issues
b. Society and social structure
c. Ethnicity
d. Foreign policy of Pakistan and challenges
e. Futuristic outlook of Pakistan

Recommended Books:

1. Afzal, M. R. (1998) Political Parties in Pakistan, Vol. I, II & III. Islamabad: National Institute of Historical and cultural Research.
2. Amin, T. Ethno -National Movement in Pakistan, Islamabad: Institute of Policy Studies, Islamabad.
3. Burki, S. J. (1980) *State & Society in Pakistan, t*he Macmillan Press Ltd
4. Burke, S. M & Ziring, L. (1993) Pakistan's Foreign policy: An Historical analysis. Karachi: Oxford University Press.

5. Haq, N. (1993) *Making of Pakistan: The Military Perspective.* Islamabad:
6. Mehmood, S. (1994) *Pakistan Political Roots & Development.* Lahore.
7. Waseem, M. (1987) Pakistan under Martial Law, Lahore: Vanguard. National Commission of Historical and Cultural Research.
8. Sayeed, K.B. (1967) t*he Political System of Pakistan.* Boston: Houghton
9. Mifflin. Aziz, K.K. (1976) *Party, Politics in Pakistan,* Islamabad: National Commission on Historical and Cultural Research.
10. Wilcox, W. (1972) *the Emergence of Bangladesh.,* Washington: American Enterprise, Institute of Public Policy Research.
11. Zahid, A. (1980) *History & Culture of Sindh.* Karachi: Royal Book Company.
12. Zaidi, A.S. (2000) *Issue in Pakistan's Economy.* Karachi: Oxford University Press.
13. Ziring, L. (1980) Enigma *of Political Development.* Kent England: Wm Dawson & Sons Ltd.

ENG- 602 ENGLISH –II (Technical Writing) Credit Hours: : 3(3-0)

Title of Course.English III (Technical Writing and Presentation Skills)

Objectives: Enhance language skills and develop critical thinking

Course Contents

Presentation skills

Essay writing

Descriptive, narrative, discursive, argumentative

Academic writing

How to write a proposal for research paper/term paper, How to write a research paper/term paper (emphasis on style, content, language, form, clarity, consistency)

Technical Report writing

Progress report writing

Note: Extensive reading is required for vocabulary building

Recommended Books:

Technical Writing and Presentation Skills

a) Essay Writing and Academic Writing

1. Writing. Advanced by Ron White. Oxford Supplementary Skills. Third Impression 1992. ISBN 0 19 435407 3 (particularly suitable for discursive, descriptive, argumentative and report writing).
2. College Writing Skills by John Langan. McGraw-Hill Higher Education. 2004.
3. Patterns of College Writing (4th edition) by Laurie G. Kirszner and Stephen R. Mandell. St. Martin's Press.

b) Presentation Skills

c) Reading

1. The Mercury Reader. A Custom Publication. Compiled by northern Illinois University. General Editors: Janice Neulib;
2. Kathleen Shine Cain; Stephen Ruffus and Maurice Scharton. (A reader which will give students exposure to the best of twentieth century literature, without taxing the taste of engineering students).

PHY-604 WAVES AND OSCILLATIONS Credit Hours: : 4(3-1)

Pre-requisites: Mechanics, Calculus II

Objective(s):

To develop a unified mathematical theory of oscillations and waves in physical systems.

Simple and Damped Simple Harmonic Oscillation: Mass-Spring System, Simple Harmonic Oscillator Equation, Complex Number Notation, LC Circuit, Simple Pendulum, Quality Factor, LCR Circuit.

Forced Damped Harmonic Oscillation: Steady-State Behavior, Driven LCR Circuit, Transient Oscillator Response, Resonance.

Coupled Oscillations: Two Spring-Coupled Masses, Two Coupled LC Circuits, Three Spring Coupled Masses, Normal Modes, Atomic and Lattice Vibrations.

Transverse Waves: Transverse Standing Waves, Normal Modes, General Time Evolution of a Uniform String, Phase velocity, Group Velocity, Pulse wave form.

Longitudinal Waves: Spring Coupled Masses, Sound Waves in an Elastic Solid, Sound Waves in an Ideal Gas.

Traveling Waves:, Traveling Waves in an Infinite Continuous Medium, Energy Conservation, Reflection and Transmission at Boundaries, Electromagnetic Waves. Standing Waves in a Finite Continuous Medium

Multi-Dimensional Waves: Plane Waves, Three-Dimensional Wave Equation, Laws of Geometric Optics, Waveguides, Cylindrical Waves.

Interference and Diffraction of Waves: Double-Slit Interference, Single-Slit Diffraction.

Recommended Books:

1. J. Pain, "The Physics of Vibrations and Waves", John Wiley, 6th ed. 2005.
2. P. French, "Vibrations and Waves", CBS Publishers (2003).
3. F. S. Crawford, Jr., "Waves and Oscillations", Berkeley Physics Course,
4. Vol. 3, McGraw-Hill, 1968.
5. A. Hirose, and K. E. Lonngren, "Introduction to Wave Phenomena",Krieger Publications, 2003.

Practical (Waves and Oscillation)

1) Oscillations of a spring pendulum, and determination of oscillation period as a function of the oscillating mass
2) The frequency of the oscillators to be determined with the electronic counter of the light barrier and the stopwatch for a particular frequency of excitation.
3) By means of a path-time measurement the phase velocity of a transverse wave is to be determined.
4) For three different frequencies the corresponding wavelengths are to be measured and it is to be shown that the product of frequency and wavelength is a constant.
5) The four lowest natural frequencies with two ends of the oscillator system fixed are to be detected.
6) Use the comb to generate two circular waves and observe the resulting interference. Increase the number of interfering circular waves up to ten by using all teeth of the comb to demonstrate Huygens' Principle.
7) Generate plane water waves and use a barrier to demonstrate diffraction at an edge. Then, form a slit and observe diffraction behind the slit. Repeat this experiment for a double-slit.

8) By using the integrated wave generator as well as the external wave generator, generate two circular waves and observe the interference. Vary the phase of the external wave generator and observe the resulting interference pattern to understand the principle of "phased array antennas".

PHY-605 MODERN PHYSICS-I Credit Hours: : 3(3-0)

Pre-requisites: Mechanics, Electricity and Magnetism

Objective(s):

To understand the non-classical aspects of Physics, the emphasis is on the applications of Quantum Physics in microscopic-scale Physics, atomic and molecular structure and processes.

Motivation for Non--Classical Physics: Blackbody radiation and ultraviolet catastrophe, Planck's quantization.

Wace-Particle Duality: Photoelectric effect, Compton effect, production and properties of X-rays, diffraction of X-rays, concept of matter waves, de Broglie relationship, **Quantum interference** electrons are waves, electron diffraction, particulate nature of matter, contributions of Faraday (atoms exist), Thomson (electron exists), Rutherford (nucleus exists) and Bohr (quantization of energies inside

an atom), wave packets and wave groups, dispersion, Heisenberg uncertainty principle, direct confirmation of quantization through Franck-Hertz experiment and spectroscopy, working of electron microscopes.

Quantum Mechanics in One Dimension: The concept of a wavefunction, time independent Schrodinger equation and interpretation of the equation, solving the Schrodinger equation for a free particle, for a particle inside an infinite box, relationship between confinement and quantization, working of a CCD camera.

Quantum Mechanical Tunneling: Concept of tunneling, reflection and transmission of wave functions from barriers, applications: radioactivity, scanning tunneling microscope, decay of black holes.

Recommended Books:

1. R.A. Serway, C.J. Moses and C.A. Moyer, “Modern Physics”, Brooks Cole, 3rd ed. 2004.
2. Paul A. Tipler and Ralph A. Llewellyn, “Modern Physics”, W H Freeman and Company 6th ed. 2012.
3. Arthur Beiser, “Concepts of Modern Physics”, McGraw-Hill, 6th ed. 2002.
4. R. M. Eisberg and R. Resnick, “Quantum Physics of Atoms, molecules, Solids, Nuclei and Particles”, John Wiley, 2nd ed. 2002.

MATH- 603 LINEAR ALGEBRA Credit Hours: : 3(3-0)

Prerequisites: Calculus I

Specific Objectives of course: Linear algebra is the study of vector spaces and linear transformations. The main objective of this course is to help students learn in rigorous manner, the tools and methods essential for studying the solution spaces of problems in mathematics, engineering, the natural sciences, and social sciences and develop mathematical skills needed to apply these to the problems arising within their field of study; and to various real world problems.

Course Outline: System of Linear Equations: Representation in matrix form. Matrices. Operations on matrices. Echelon and reduced echelon form. Inverse of a matrix (by elementary row operations). Solution of linear system. Gauss-Jordan method. Gaussian elimination. Determinants: Permutations of order two and three and definitions of determinants of the same order. Computing of determinants. Definition of higher order determinants. Properties. Expansion of determinants. Vector Spaces: Definition and examples, subspaces. Linear combination and spanning set. Linearly Independent sets. Finitely generated vector spaces. Bases and dimension of a vector space. Operations on subspaces, Intersections, sums and direct sums of subspaces. Quotient Spaces. Linear mappings: Definition and examples. Kernel and image of a linear mapping. Rank and nullity. Reflections, projections, and homotheties. Change of basis. Eigen-values and eigenvectors. Theorem of Hamilton-Cayley. Inner product Spaces: Definition and examples. Cauchy inequality. Orthogonal and orthonormal basis. Gram Schmidt Process. Diagonalization.

Recommended Books:

1. Ch. W. Curtis, Linear Algebra, Springer 2004.
2. T. Apostol, Multi Variable Calculus and Linear Algebra, 2nd ed., John Wiley and sons, 1997.
3. H. Anton, C. Rorres , Elementary Linear Algebra: Applications Version, 10th Edition, John Wiley and sons, 2010.
4. S. Friedberg, A. Insel, Linear Algebra, 4th Edition, Pearson Education Canada, 2003.
5. S. I. Grossman, Elementary Linear Algebra, 5th Edition, Cengage Learning, 2004.

PHY-606 PROPERTIES OF MATTERS Credit Hours: 04(3-1)

Objective To study some basic properties of matter including elasticity, elastic modulus and liquid flow, viscosity of a liquid.

CONTENTS:

ELASTIC PROPERTIES OF MATTER: Physical Basis of Elasticity; Tension, Compression & shearing, Different Moduli of Elasticity; Poisson's Ratio; Relation between Elastic Moduli; Experimental Methods for determination of Elastic Moduli; Determination of Poisson's Ratio.

VISCOSITY: Streamline and Turbulent Flow; Flow of a Liquid through a Capillary Tube (Poiseuille's Formula); Experimental Determination of the Coefficient of Viscosity of a Liquid; Motion in a Viscous Medium (Stokes's Formula'); Measurement of viscosity of liquid by falling sphere method (Stokes's method).

SURFACE TENSION: Molecular Theory of Surface Tension; Angle of Contact and Curvature of Liquid Surface; Surface Energy and Surface Tension; Formation of Drops and Bubbles; Capillarity and Measurement of Surface Tension of a Liquid.

Practical:

1. Modulus of Rigidity by Static method (Barton's Apparatus).
2. Modulus of Rigidity by Dynamic method (Maxwell's needle).
3. Measurement of viscosity of liquid by Stoke's / Poiseulli's method.
4. Surface tension of water by capillary tube method.
5. To study the conservation of energy (Hook's law).

BOOKS RECOMMENDED

1. Resnick, D. Halliday and K.S. Krane 'Physics' Volume I and II 5/e .John Wiley (2002)
2. Halliday. R. Resnick and J. Walker 'Fundamentals of Physics' John Wiley Latest Edition
3. I.D. Young and R.A. Freedman 'Sears and Zamansky's University Physics' 11/e Pearson Education (2004)
4. P.A. Tipler 'Physics for Scientists and Engineers' 5/e, W.H. Freeman (2003)
5. R..A. Serway and J.W. Jewett Jr. 'Physics for Scientists and Engineers' 6/e or Latest Edition, Thomson (2004)
6. D C. Giancoli 'Physics for Scientists and Engineers with Modern Physics' 2/e or Latest edition Prentice Hall

ENG-603 COMMUNICATION SKILLS Credit Hours: : 3(3-0)

Objectives: Enable the students to meet their real life communication needs.

Course Contents

Paragraph writing

Practice in writing a good, unified and coherent paragraph

Essay writing

Introduction

CV and job application

Translation skills, Urdu to English

Study skills

Skimming and scanning, intensive and extensive, and speed reading, summary and précis writing and comprehension

Academic skills

Letter/memo writing, minutes of meetings, use of library and internet

Presentation skills

Personality development (emphasis on content, style and pronunciation)

Note: documentaries to be shown for discussion and review

Recommended Books:

Communication Skills

a) Grammar

1. Thomson, A. J. & Martinet, A. V. (1986) Practical English Grammar, Exercises 2., Third edition, Oxford University Press, ISBN 0 19 431350 6.

b) Writing

1. Boutin, M. C., Brinand, S. & Grellet, F., (1993) Writing. Intermediate, Oxford Supplementary Skills, Fourth Impression, ISBN 019 435405 7 Pages 45-53 (note taking).

Nolasco, R. (1992) Writing. Upper-Intermediate, Oxford Supplementary Skills. Fourth Impression, ISBN 0 19435406 5 (particularly good for writing memos, introduction to presentations, descriptive and argumentative writing).

c) Reading

1. Tomlinson, B. & Ellis R., (1991) Oxford Supplementary Skills. Third Impression,

PHY- 607 CIRCUIT THEORY Credit Hours: 4(3-1)

OBJECTIVE

To study the combinations of circuit different, related laws and rules, different techniques of circuit analysis, network theorems, charge storing devices and make the students familiar with circuit maker software.

CONTENTS

(1) Introduction:

Resistance, temperature effect on resistance, thermistors, super conductors, types of resistors, varistor, strain gauge, resistor color code, ohms law, power, and energy, efficiency, home electricity billing system.

(2) Series and parallel circuits:

series circuit, voltage sources in series, Kirchhoff's voltage law, voltage divider rule, voltage sources and ground, voltage regulation and the internal
resistance of voltage sources, protoboards (breadboards), parallel circuit, Kirchhoff's current law, current divider rule, voltage sources in parallel, open and short circuits, series and parallel combinations, potentiometer loading

(3) Method of analysis:

current sources, source conversions, current sources in parallel, current sources in series, branch-current analysis, mesh analysis (general approach), mesh analysis (format approach), nodal analysis (general approach), nodal analysis (format approach), bridge networks, y- delta and delta –y conversions,

(4) Network theorem:

Superposition theorem, Thévenin's theorem, Norto's theorem, maximum power transfer theorem, Millman's theorem, substitution theorem, reciprocity theorem

(5) Capacitors:

Capacitance, capacitor construction, internal structure and capacitance analysis, types of capacitors, temperature effects, capacitor labeling, transients in capacitive networks (the charging phase, discharging phase), instantaneous values, capacitors in series and in parallel, energy stored by a capacitor

(6) Inductors:

Magnetic field, electromagnets and their applications, inductance, inductor construction, induced voltage, RL transients, reluctance, ohm's law for magnetic circuits, magnetizing force, Ampère's circuital law, RLC series and parallel circuits.

Practical:

1. Prove of Kirchhoff voltage law using Series circuits.
2. Prove of Kirchhoff current law using parallel circuits.
3. Determine the charging and discharging effect of capacitor.
4. Determine instantaneous values, capacitors in series and in parallel
5. Study of RL/ RLC circuits

SOFTWARE: Analysis of circuits in all chapters using multisim or circuit maker software

BOOKS RECOMMENDED

1. Robert L. Boylestad. Introductory Circuit Analysis, 12th /e,

2. Hayt & Kimberly Circuit Analysis - Electrical and Computer Engineering, McGraw-Hill Book Company 8th /e

PHY-608 OPTICS Credit Hours: 3(3-0)

Pre-Requisites: Waves and Oscillations

Objective(s): To understand the optical phenomena and their uses in physical systems

Propagation of Light & Image Formation: Huygens' Principle, Fermat's Principle, Laws of Reflection and Refraction, Refraction at a Spherical Surface, Thin Lenses, Newtonian Equation for a Thin Lens.

Matrix Methods in Paraxial Optics: Ray Transfer Matrices, Thick Lens, Significance of System Matrix Elements, Cardinal Points of an Optical System with examples, Optical Instruments including Simple Magnifiers, Telescopes and Microscopes, Chromatic and Monochromatic Aberrations, Spherical Aberrations, Coma, Distortion, Stops, Pupils, Windows.

Superposition & Interference: Standing Waves, Beats, Phase and Group Velocities, Two-Beam and Multiple-Beam Interference, Thin Dielectric Films, Michelson and Fabry-Perot Interferometers, Resolving Power, Free-Spectral Range.

Polarization: Jones Matrices, Production of Polarized Light, Dichroism, Brewster's Law, Birefringence, Double Refraction.

Fraunhofer Diffraction: from a Single Slit, Rectangular and Circular Apertures, Double Slit, Many Slits, Diffraction Grating, Dispersion, Resolving Power Blazed Gratings.

Fresnel Diffraction: Zone Plates, Rectangular Apertures, Cornu's Spiral

Coherence & Holography: Temporal Coherence, Spatial Coherence, Holography of a Point object and an Extended Object

Laser Basics: Stimulated Emission, Population Inversion, Resonators, Threshold and Gain, Multi-layered Dielectric Films.

Recommended Books:

1. F.Pedrotti, L.S. Pedrotti and L.M. Pedrotti,"Introduction to Optics", Pearson Prentice Hall, 3rd ed. 2007.
2. E. Hecht and A. Ganesan, "Optics", Dorling Kindersley, 4th ed. 2008.
3. M. V. Klein and T. E. Furtak, "Optics", John Wiley, 2nd ed. 1986.
4. K. K Sharam, "Optics: Principles and Applications", Academic Press, 2006.

5. C. A. Bennett, "Principles of Physical Optics", John Wiley, 2008.

MATH-604 DIFFERENTIAL EQUATIONS Credit Hours: 3(3-0)

Prerequisites: Calculus I

Specific Objectives of course: To introduce students to the formulation, classification of differential equations and existence and uniqueness of solutions. To provide skill in solving initial value and boundary value problems. To develop understanding and skill in solving first and second order linear homogeneous and nonhomogeneous differential equations and solving differential equations using power series methods. To understand the skill used in solving partial differential equations and their applications.

Course Outline:

Introduction to differential equations: Definitions and terminology, Initial-value problems, Linear and nonlinear equations, general solution, Particular solution, explicit solution, implicit solution, Differential equations as mathematical models.

First order differential equation: Basic concepts, formation and solution of differential equations. Separable variables, Exact Equations, Homogeneous Equations, Linear equations, integrating factors. Some nonlinear first order equations with known solution, differential equations of Bernoulli and Ricaati type, Clairaut equation. Applications of first order differential equations.

linear differential equations of higher order: Initial value and boundary value problems, linear dependence and independence, solutions of linear equations, constructing a second solution from a known solution, homogeneous linear equations with constant coefficients, undetermined coefficients, variation of parameters, applications of second order ODEs (simple harmonic motion, damped and forced oscillators, electrical circuits and springs)

Differential equations with variable coefficients: Cauchy-Euler equation, power series solution of differential equations – solutions about ordinary and singular points-Legendre's and Bessel's equations as examples,

Partial Differential Equation: Introduction to important PDEs in Physics (wave equation, diffusion equation, Poisson‟s equation, Schrodinger‟s equation), general form of solution, general and particular solutions (first order, inhomogeneous, second order), characteristics and existence of solutions, uniqueness of solutions, separation of variables in Cartesian coordinates, superposition of separated solutions, separation of variables in curvilinear coordinates,

Recommended Books:

1. Dennis G. Zill and Michael R., Differential equations with boundary-value problems by Cullin 5th Edition Brooks/Cole, 1997.
2. William E. Boyce and Richard C. Diprima, Elementary differential equations and
3. boundary value problems, Seventh Edition John Wiley & Sons, Inc
4. V. I. Arnold, Ordinary Differential Equations, Springer, 1991.
5. T. Apostol, Multi Variable Calculus and Linear Algebra, 2nd ed., John Wiley and sons, 1997.

PHY-609 MODERN PHYSICS-II Credit Hours: 4(3-1)

Pre-requisites: Modern Physics-I

Objective(s): To understand the non-classical aspects of Physics, the emphasis is on the applications of Quantum Physics in microscopic-scale Physics, atomic and molecular structure and processes.

Special Theory of Relativity: Inertial and non-inertial frame, Postulates of Relativity, The Lorentz Transformation, Derivation, Assumptions on which inverse transformation is derived, Consequences of Lorentz transformation, Relativity of time, Relativity of length, Relativity of mass, Transformation of velocity, variation of mass with velocity, mass energy relation and its importance, relativistic momentum and Relativistic energy, (Lorentz invariants)

Quantum Mechanics in Three Dimensions: The Hydrogen atom, orbitals, angular momentum and its quantization, orbital magnetism, concept of spin, Building of the periodic table, magnetic resonance and MRI, why is iron magnetic? White dwarfs, and neutron stars.

Nuclear Structure: Size and structure of nucleus, nuclear forces, radioactivity and nuclear reactions, radiocarbon dating.

Practical:

1. Determination of ionization potential of mercury.
2. Variation of Photoelectric current with intensity of light.
3. To study the characteristic curves of a G. M. tube.
4. Determination of range of α particle.
5. Study of the parameter of wave i.e. amplitude, phase and time period of a complex signal on an oscilloscope.

Recommended Books:

1. R.A. Serway, C.J. Moses and C.A. Moyer, "Modern Physics", Brooks Cole, 3rd ed. 2004.
2. Paul A. Tipler and Ralph A. Llewellyn, "Modern Physics", W H Freeman and Company 6th ed. 2012.
3. Arthur Beiser, "Concepts of Modern Physics", McGraw-Hill, 6th ed. 2002.
4. R. M. Eisberg and R. Resnick, "Quantum Physics of Atoms, molecules,
Solids, Nuclei and Particles", John Wiley, 2nd ed. 2002.

CHEM- 601 APPLIED CHEMISTRY Credit Hours: 3(3-0)

OBJECTIVE

To study the basic concepts of chemistry including periodic table, hydrogen and hydrides, electrochemical cells, hydrocarbons, organic polymers, Chromatography and spectroscopy.

CONTENTS:

Basic Concepts of Chemistry: Periodic table, Electronegativity, Vander wall forces, Basic concepts in chemical bonding, Localized and delocalized chemical bonding, Resonance effect, inductive effect, dipole moment, hyper conjugation, types of organic reactions, Nomenclature of organic compounds: Common and trivial names, systematic naming of organic compounds mono functional and bi-functional by IU PAC rules. Hydrogen and Hydrides: Introduction, occurrence, preparation, properties and uses of hydrogen. Hydrides, classification of hydrides, preparation, properties and uses of various types of hydrides. Electrode Potential and Electrochemical Series: Electrochemical cell, salt bridge, representation of electrodes, electrode potential, types of electrode potential, electrochemical series. Introduction to dry cell and its types, Hydrocarbons: Open chain: Introduction and classification of Hydrocarbons, Closed chain(Alicyclic)-synthesis, reactions and relative stability of small and medium sized cycloalkanes and reactivity, addition and oxidation reaction, preparation, and reactivity of naphthalene. Aromatic compounds: Structure of benzene, aromaticity, electrophilic, substitution including orientation and reactivity, addition and oxidation reaction, preparation, and reactivity of naphthalene. Organic Polymers: Introduction and scope of polymers, classification and general methods for the preparation of polymers, polymerization techniques, polymer structure. Chromatography and spectroscopy: a) Chromatographic methods: Thin layer and column, b) Spectroscopic methods: IR, UV, NMR and mass spectroscopy.

BOOKS RECOMMENDED

1. M. Younas, Organic Spectroscopy and Chromatography, Lahore Ilmi Kitab Khana, 1998

2. M. Younas, A Textbook of Organic Chemistry, Publication: Lahore Ilmi Kitab Khana, 2011
3. M. Zafar Iqbal, Text Book of Inorganic Chemistry, Ilmi Kitab Khana, 1990.
4. JohnE. Mcmurry, Organic Chemistry, Mary Finch, 8th Edi., 2012.
5. Rehman, A., Text book of Organic Chemistry. Karwan book house.
6. March, J., Advanced Organic Chemistry. John Wiley and sons.
7. Pine., S.H., Organic Chemistry, McGraw Hill, Inc.
8. Sykes, F., Organic reaction Mechanism.
9. *Younas, M., Organic spectroscopy, A.H. Publisher.*
10. Vogel, A.I, Organic analysis, Longman Green & Co.
11. *Solomon, T.W.G., Organic Chemistry, John Wiley and sons.*

PHY-610-MATHEMATICAL METHODS OF PHYSICS-I Credit Hours: 3(3-0)

Pre-requisite: Mechanics, Differential Equations, Linear Algebra

Objective(s): The course aims at developing understanding about fundamental concepts of PDEs theory, identification and classification of their different types, how they arise in applications, and analytical methods for solving them.

Contents:

(1) VECTOR. Vector Integration; Line, Surface and Volume Integrals; Green's Theorem in the plane: Gauss's Divergence Theorem; Stokes's Theorem; Curvilinear Coordinates; Orthogonal Curvilinear Coordinates; Representation of Gradient.

(2) FOURIER ANALYSIS. Definition and Examples of Fourier Series; Half-range Expansions; Complex form of Fourier Series; Physical Applications (i.e., Analysis of Periodic Wave forms); Fourier Integral Theorem; Sine and Cosine Transforms; Complex Fourier Transform; Properties of Fourier Transform (Linearity, Time Shift, Frequency Shift, Scaling and Symmetry Properties) Convolution integral theorem.

(3) THE LAPLACE TRANSFORM. Definition; Laplace Transform of Elementary Functions; Properties of Laplace Transform; Inverse Laplace Transform and its Properties; The Convolution Theorem; Application to the Solution of Differential Equations with Constant Coefficients.

RECOMMENDED BOOKS.

1. G.B. Arfken and H.J. Weber "Mathematical Methods for Physicists" 6/e Academic Press (2005).
2. M.L. Boas "Mathematical Methods in the Physical Science" 3/e John Wiley (2005).

3. S.H. Hassani " Mathematical Physics: A Modern Introduction to its Foundation" Springer (1999).

4. H.Jefreys and B. Jeffreys " Methods of Mathematical Physics" 3/e Cambridge University Press (1999). 5. E. Kreyszig" Advanced Engineering Mathematics" 9/e John Wiley (2006).

PHY-611 CLASSICAL MECHANICS Credit Hours: 3(3-0)

Pre-requisites: Mechanics

Central Force Motion: Review of Newtonian Mechanics, Central Force, the two-body problem and reduce mass, General properties of Central force motion, effective potential and classification of

orbits, Kepler's laws, stability of circular orbits, Scattering in a Central Force Field. hyperbolic orbits and Rutherford scattering, scattering cross-sections. Center of mass co-ordinate system

The Lagrange Formulation of Mechanics: Degree of freedom and Constraints, Generalized co-ordinates, Virtual work, D'Alembert's principle, Lagrange's Equations and applications, Equivalence of Lagrange 's and Newton's Equation

Hamiltonian Dynamics, Hamilton's principle, Lagrange's equation from Hamilton's principle, integrals of motion, non-conservative system and generalized potential, the Hamiltonian of a dynamical system(Legender transformation), Hamilton's canonical equations, canonical transformations, Poisson brackets, phase space and Liouville's theorem.

Motion in Non-Inertial Systems: Accelerated translational co-ordinate system, dynamics in rotating co-ordinate system, Coriolis Force, motion of a particle near the surface of the earth

The Motion of Rigid Bodies: The Euler Theorem, rotational kinetic energy and angular momentum, the inertia tensor, Euler equations of motion, Euler's Angles, motion of a torque-free symmetrical top, stability of rotational motion.

Recommended Books:

1. T. L. Chow, "Classical Mechanics", John Wiley, 1995.
2. T. Kibble and F. Berkshire, "Classical Mechanics", World Scientific, 5th ed.2004.

PHY-612 SOLID STATE PHYSICS Credit Hours: 3(3-0)

Pre-requisites: Mechanics

1) CRYSTAL STRUCTURE AND INTERATOMIC FORCES

a) **Crystal Structure**: Introduction, Crystal Translation Vectors, Symmetry Operations, Types of Lattices, Lattice Planes and Miller Indices, Simple Crystal Structures (Sodium Chloride, Cesium Chloride, Hexagonal closed Packed, Diamond Cubic and Zinc Sulphide Structures), Reciprocal Lattice and its Properties.

b) **Crystal Diffraction**: Introduction , Bragg's Law and X-ray Spectrometer, Experimental Methods in X-ray diffraction (Laue , Rotating crystal and Powder Method), Analysis of Cubic Structure by Powder Method.

c) **Crystal Binding**: Binding Energy of a crystals, Ionic, Covalent, Metallic, Van der Waal Hydrogen Bonded Crystals.

2) LATTICE DYNAMICS

Introduction, One dimensional Mono and Diatomic Lattices, Dispersion Curves, Three Dimensional Lattice.

3) THERMAL PROPERTIES OF SOLIDS

Introduction, Classical theory of Specific Heat, Mean energy of Quantized linear Harmonic Oscillator, Einstein's and Debye's Theory of Specific Heatand comparison with Experimental results, Thermal Conductivity, Phonon-Phonon Interaction (Normal and Umklapp Processes).

RECOMMENDED BOOKS

1. C Kittle 'Introduction to Solid State Physics' 8/e John Wiley & Sons, New York 2004.
2. J.R. Christman'Fundamentals of Solid State Physics' John Wiley & Sons, New York (1988)
3. M A Wahab 'Solid State Physics: Structure and Properties of Materials' 2/e Narosa Publications House, New
4. Delhi, 2005.
5. C M Kachhava 'Solid State Physics' Tata McGraw Hill, Hew Delhi, 1990.
6. M A Omar 'Elementary Solid State Physics' Adison Wesley, 1975.
7. S.O. Pilai'Solid State Physics' 6/e New Age International (P) Ltd, New Delhi (2005).

8. J P Mckelvey 'Solid State and Semiconductor Physics' Robert E. Krieger Publishing Company Malabar, Florida.

PHY-613 - ELECTRONICS-I Credit Hours: 4(3-1)

Pre-requisites: Modern Physics

(1) Microfabrication

An introduction to Crystal Growth and Silicon Wafer Preparation, Crystalline Materials, Poly and single crystals, Crystal Orientation, Crystal Growth, Czochralski (CZ) method, Liquid encapsulated Czochralski (LEC), Float zone method, Crystal and Wafer Quality, Wafer Preparation, Wafer Terminology, Basic Wafer-Fabrication Operations, Circuit design, Chip Terminology

(2) Diodes and their applications.

Semiconductors, Conductors and Insulators; N-Type Semiconductors; The PN-Junction and it's Basing; Current-Voltage Characteristic of a PN-Junctions; The Diode and its Models. Half-wave Rectifier; Full-wave Rectifier (Simple and Bridge); Smoothing Circuits (Series Inductor, Shunt Capacitor, LC and CLC filter); Clipper and Clamper Circuits; Voltage Multiplier circuits; Zener Diodes; Voltage Regulation; Varactor Diode; Optical Diodes (LED and Photodiode); LED Applications; Current Regulator Diode; The Schottky Diode; The PIN Diode; The Tunnel Diode; The laser Diode.

(3) Bipolar junction transistor.

Basic Transistor Operation; Transistor Characteristics and Parameters (Alpha and Beta Parameters, Current and Voltage Analysis, Characteristic Curves, DC Load Line, Variation of Beta with Temperature); Transistor as an Amplifier: Transistor as a Switch; Photo transistor, The DC Operating Point; Voltage Divider Bias; Base Bias; Emitter Bias, Emitter feedback bias, Collector Feedback Bias

(4) Bipolar junction transitor amplifiers.

Amplifier Operation; Transistor AC Equivalent Circuits (r-Parameters, h – parameters); Common Emitter Amplifier DC and AC Analysis, Voltage Gain, Current Gain, Power Gain); Common Collector Amplifier (Voltage Gain; Input Resistance; Current Gain; Power Gain); Darlington Pair; Common Base Amplifier (Voltage Gain, Input Resistance, Current Gain, Power Gain); Multistage Amplifiers, Differential amplifier

Practical

1. IV characteristics of forwarded and reversed biased PN junction diode
2. To perform half- Wave Rectification and to calculate its
    a. Ripple factor
    b. Form factor
    c. Efficiency
3. To perform full-Wave Rectification and to calculate its
    a. Ripple factor
    b. Form factor
    c. Efficiency
4. To design and assemble a common-emitter voltage amplifier and study its frequency response.
5. To design and assemble a common-collector amplifier (emitter follower) and study its frequency response.
6. To design and assemble a two –stage RC coupled amplifier and study its frequency response.
7. To design and assemble a class' A' power amplifier and study its frequency response.
8. To design & assemble a class 'B' (complementary symmetry) power amplifier and study its frequency response.
9. To design and assemble a Push-Pull class' B' amplifiers study its frequency repose.

10. To design and assemble a transistorized split load phase inverter.

Recommended Books:

1. T.L.Floyd' Electronic Devices 9/e Prentice Hall (2012) Main Text Book.
2. A.P. Malvino' Electronic Principles' 7/e with CD-ROM Glencoe/ McGraw-Hill (2007).
3. D.A. Bell' Electronic Devices and Circuits'4/e Prentice Hall (1999).
4. C.J. Savant Jr. M.S. Roden and G.L Carpenter' Electronic Design Circuit and System' The Benjamin Publishing Co., California (1994).
5. B. Grob, "Basic Electronics", McGraw-Hill, Tch ed. 1997.
6. B. Streetman and S. Banerjee "Solid State Electronics Devices", Prentice
7. Hall, 6th ed. 2005.
8. R. T. Paynter, "Introductory Electric Circuits", Prentice Hall, 1998.

PHY-614-ELECTROMAGNETIC THEORY-I Credit Hours: 3(3-0)

Pre-requisites: Electricity and Magnetism, Calculus-II

(1) FUNDAMENTAL CONCEPTS

Recapitulation of the Fundamental Concepts; Electric Field Intensity **E**, Electric Displacement Vector **D**, Magnetic Induction **B**, Magnetic intensity **H**, Maxwell's equations (differential and integral form), Pointing Theorem and Energy Conservation, Equation of Continuity.

(2) TIME DEPENDENT ELECTROMAGNETIC FIELDS:

Potential Function and Electromagnetic Fields; Retarded Potential; Lienard-Wiechart Potentials; Field of a Uniformly Moving Potential Charge; Radiation by Accelerated Charges.

(3) SOLUTION OF ELECTROSTATICS PROBLEMS:

Poisson and Laplace Equations; Uniqueness Theorem; Solution of Laplace Equation in Cartesian, Spherical and Cylindrical Polar Coordinates; Electrostatic Images and Simple Application (Point Charge and Conducting Infinite Plane, Point Charge and a Conducting Sphere, Line Charges and Line images); Solution of Poisson's Equation.

(4) REFLECTION AND REFRACTION OF ELECTRMAGNETIC WAVES

Laws of Reflection and Refraction; Fresnel's Equations; Reflection and Refraction at the boundary of two Ideal Dielectrics (Normal and Oblique Incidence); Reflection and Refraction at the surface of a Perfect conductor (Normal and Oblique Incidence); Total Internal Reflection; Surface Impedance; Surface Impedance.

Recommended Books:

1. H.C Ohanion 'Classical Electrodynamics' Allyn and Bacon Ine, Massachusetts (1988).
2. Roatd K Wangsness' Electromagnetic fields and waves'W H freeman and Co., New York. (1978).
3. P.C. Lorrain and D.R. Corson' Electromagnetic fields and Waves' W.H. Freeman, New York (1978).
4. C.R. Paul, K. W. Whites and S.A. Nasar' Introduction to Electromagnetic Fields' 3/e McGraw-Hill (1998).
5. A.M. Portis' Electromagnetic fields' John Wiley & Sons, New York (1978).
6. D.J. Griffiths' Introduction to Electrodynamics' 3/e Pearson Education (2009).
7. David K. Cheng' Field and Wave Electromagneties' Pearson Education (1989).
8. J.D. Jackson' Classical Electrodynamics' 3/e John Wiley (2007).
9. J. Reitz, F.Millford and R. Christy' Foundation of Electromagnetic Theory' 4/e Addison-Wesley (1999).
10. E.C. Jordan & K.G. Balmain' Electromagnetic Waves & Radiating Systems' Prentice Hall (1968).
11. W.T.Scott' The Physics of Electricity and Magnetism' John Wiley (1966).
12. E.V. Bohn' Introduction to Electromagnetic Fields and Waves; Addison Wesley (1968).
13 M. N. O. Sadiku, "Elements of Electromagnetics", Oxford University Press, 5th ed. 2009.
14. F. Melia, "Electrodynamics", University of Chicago Press, 2001.

15. Hearld J and W. Muller-Kristen, "Electrodynamics", World ScientificPublishing, 2nd ed. 2011.

PHY-615 MATHEMATICAL METHODS OF PHYSICS-II Credit Hours: 3 (3-0)

Pre-requisite: Mathematical Methods of Physics-I

Objective(s):

Introduction to special functions and complex analysis

(1) SPECIAL FUNCTIONS.

(a)The Gamma and Beta Functions.

(b) Bessel Functions; Bessel Differential Equation and its Solution; Bessel Functions of First and Second Kind; Generating Function; Recursion Relations; Orthogonality and Normalization Properties of Bessel Functions of First Kind.

(c) Legendre Functions of First Kind: Legendre Differential Equation and its solution; Legendre Functions; Rodrigues's Formula; Generating Function; Recursion Relations; Orthogonality and Normalization Properties.

(d) Associated Legendre Functions: Introduction; Associated Legendre Functions;

(e) Hermite Functions: Hermite Differential Equation and its Solution; Rodrigues's Formula; Generating Function; Recursion Relations; Orthogonality and Normalization Properties.

(f) Laguerre Functions: Laguerre Differential Equation and its Solution; Rodrigues's Formula; Generating Function;Recursion relations; Orthogonality and Normalization Properties.

(2) COMPLEX ANALYSIS.

(a) Complex differentiation: Derivative; Analytic function; Cauchy-Riemann Equations; Harmonic Function; Derivative of Elementary Functions.

(b) Complex Integration: Definite Integrals; Contours; Line Integration; Cauchy-Goursat Theorem; Cauchy's Integral Formula.

(c) Residues and Poles: The Residue theorem; Methods of Finding Residues and Poles; Evaluation of Definite Integrals.

RECOMMENDED BOOKS.

1. C.W Wong 'Introduction to Mathematical Physics: Methods & Concepts' Oxford University Press. (1995).
2. E. Saff and A, Snider 'Fundamentals of Complex Analysis with Applications to Engineering Science and Mathematics' 3/e Pearson Education (2003).
3. E.Butkov' Mathematical Physics' Addison-Wesley (1968).
4. P.K. Chattopadhyay' Mathematical Physics' Wiley Eastern Ltd, New Delhi (1990).
5. A. Jeffrey' Advanced Engineering Mathematics' 3/e Academic Press (2002).
6. B.D. Gupta' Mathematical Physics' 3/e Vikas Publishing, New Delhi (2004).

PHY-616 THERMAL AND STATISTICAL MECHANICS Credit Hours: 3(3-0)

1) INTRODUCTION TO STATISTICAL MECHANICS

Statistical Basis, Probability, Permutation and combination, Macrostate and Microstate, Thermodynamic Probability, Most Probable state, Concept of cell in a compartment, Position space, Momentum space, Phase Space.

2) KINETIC THEORY OF GASSES.

Velocity space, Maxwell's law of Distribution of Molecular velocities, Mean velocity, Root mean square velocity and most probable velocity of molecules, Kinetic Interpretation of Temperature, Degree of freedom and principle of Equipartition of energy.

3) PARTITION FUNCTION.

Relations of Partition Function with Thermodynamic Variables; Examples (An assembly of Simple Harmonic Oscillators, Pauil and Van Vleek Paramagnetism); Theorem of Equipartition of Energy.

4) STATISTICAL SYSTEMS.

Maxwill-Boltzmann, Bose-Einstein and Fremi-Dirac Statistical Systems; Examples of Thermodynamics of these Systems; Black Body Radiation; Gas of electrons in solids.

5) STATISTICAL MECHANICS OF INTERACTING SYSTEMS.

Lattice Vibrations in Solids; Van der Waal Gas; Mean Field Calculation; Ferromagnets in Mean Free Approximation .

RECOMMENDED BOOKS.

1. E. Mandl' Statistical Physics 2/e John Wiley, London (1988).
2. F. Reif' Fundamentals of Statistical and Thermal Physics' McGraw-Hill (1965).
3. B.N. Roy' Fundamentals of Classical and Statistical thermodynamics' John Wiley (2002).
4. S.K. Sinha' Introduction to Statistical Mechanics' Narosa Publishing House, Delhi (2005).
5.BRIJ Lal, Dr. N. SUBRAHMANYAM , P.S HEMNE "Heat Thermodynamics and Statistical Physics", S.CHAND SERIES (2011).

PHY-617 SOLID STATE PHYSICS II Credit Hours: 4(3-1)

FREE ELECTRON THEORY OF METALS.

Drude Model; D.C. Electrical Conductivity; Hall Effect in Metals; A.C. Electrical Conductivity; Thermal Conductivity in Metals; Wiedemann-Franz Law, Summerfield Model: Motion of Electrons in one-dimensional infinite Potential well and Three-dimensional Potential Well: Fermi-Dirac Statistics: Density of Energy States; Fermi Energy; Effect of Temperature on Fermi Energy; Applications of Free Electron Theory (Electronic Specific Heat and Thermionic Emission).

BAND THEORY OF SOLIDS.

Introduction; The Bloch Theorem; The Kronig-Penny Model; Analysis and existence of Energy Bands; The Distinction among Metals, Insulators and Semiconductors; Brillouin Zones and Reduced Zone Schemes; Effective Mass of Electron; Nearly Free Electron Model; Tight Binding Approximation.

ELEMENTRY SEMICONDUCTOR PHYSICS.

Brief Review; Intrinsic and Extrinsic Semiconductors; Electron and Hole Concentration in Intrinsic Semiconductors; Product of Electron and Hole Concentration and its Analysis; Position of Fermi Level; Carrier Concentration in Extrinsic Semiconductors; Temperature Dependence of Carrier Concentration; Motion of Charge Carriers; Hall Effect in Semiconductors; Cyclotron Resonance.

DIELECTRIC SOLIDS.

The Macroscopic Concept of Polarization; The Microscopic Concept of Polarization; Electronic, Ionic, Orientational, Space Charge Polarization etc.; The Local Field; Clausius-Mossotti Equation; Dielectric in an Alternating Field (The Complex Dielectric Constant and Dielectric Loss).

PRACTICALS:

1. To determine the charge on an electron by Millikan's oil drop experiment.
2. To determine of (e/m) of an electron by magnetron method.
3. To determine specific charge (e/m) of an electron using fine Beam Tube.
4. To determine the speed of light using Foucault-Michelson method.
5. To determine of value of Planck's constant by photocell.
6. To determine the value of Planck's constant by spectrometers method.
7. To determine the value of Cauchy's constants for glass.
8. To determine the wavelength of sodium light using a Michelson interferometer.
9. Franck-Hertz experiment.
10. Zeeman Effect for a line in the spectrum of helium.

11. Stern-Gerlach Experiment.
12. Compton Effect.
13. X-Ray Diffraction

RECOMMENDED BOOKS

(1). C Kittle 'Introduction to Solid State Physics' 8/e John Wiley & Sons, New York 2004
(2). N W Ashcroft & N D Mermin 'Solid State Physics' Holt Rinehart and Winston, NY 1976.
(3). J.R. Hook and H.E. Hall'Solid State Physics' 2/e John Wiley & Sons, Chichester (1991).
(4). D A Neamen 'Semiconductor Physics and Devices' 2/e Irwin McGraw Hill, Boston, 2003.
(5). B G Streetman and S Banerjee 'Solid State Electronic Devices' Pearson Education, 2000.
(6). A J Dekker 'Solid State Physics' Prentice Hall publication Inc. Englewood Cliffs NJ, 1958.
(7). H.M. Rosenberg'The Solid State: An Introduction to the Physics, Material Science and Engineering' 3/e OxfordUniversity Press, Oxford (1988).
(8). A AZaky and Hawley 'Dielectric Solids' Dover Publications Inc. New York, 1970.

PHY-618 ELECTROMAGNETIC THEORY II Credit Hours: 3(3-0)

WAVE GUIDES AND GUIDED WAVES.

Waves Guided by Perfectly Conducting Parallel Plates (Transverse Electric Waves, Transverse Magnetic Waves and Transverse Electromagnetic Wave); Cylindrical Wave Guide, Rectangular and Circular Wave Guides (TE and TM mode analysis), Attenuation in Wave Guides, Elementary Concepts of Cavity Resonator, (Rectangular Circular and Spherical Cavity Resonators); Quality Factor of Rectangular Cavity Resonator, Wave Equations for the Grounded Dielectric Slab (TE and TM modes

ELECTROMAGNETISM AND SPECIAL RELATIVITY.

Einstein Postulates; The Geometry of Space-Time; The Lorentz transformations and its Consequences; Addition of Velocities; Relativistic Momentum and Energy; Relativistic Kinetics; Relativistic Dynamics; Magnetism as a Relativistic Phenomenon; Lorentz Transformations of Electric and Magnetic fields.

COVARIANT FORMULATION OF VACUUM ELECTRODYNAMICS.

Four-Vectors, Four-current density of and Four-potential; The Electromagnetic Field Tensor; Electrodynamics in tensor Notation; Relativistic Potentials Covariant form of Maxwell's Equations; Equation of motion of a charged particle in an Electromagnetic field; Maxwell's equation from the principle of least action; The Energy-Momentum Tensor of Electromagnetic field.

RECOMMENDED BOOKS.

1. H.C Ohanion 'Classical Electrodynamics' Allyn and Bacon Ine, Massachusetts (1988).
2. Roatd K Wangsness' Electromagnetic fields and waves'W H freeman and Co., New York. (1978).
3. P.C. Lorrain and D.R. Corson' Electromagnetic fields and Waves' W.H. Freeman, New York (1978).
4. C.R. Paul, K. W. Whites and S.A. Nasar' Introduction to Electromagnetic Fields' 3/e McGraw-Hill (1998).
5. A.M. Portis' Electromagnetic fields' John Wiley & Sons, New York (1978).
6. D.J. Griffiths' Introduction to Electrodynamics' 3/e Pearson Education (2009).
7. David K. Cheng' Field and Wave Electromagneties' Pearson Education (1989).
8. J.D. Jackson' Classical Electrodynamics' 3/e John Wiley (2007).
9. J. Reitz, F.Millford and R. Christy' Foundation of Electromagnetic Theory' 4/e Addison-Wesley (1999).

10. W.T.Scott' The Physics of Electricity and Magnetism' John Wiley (1966).

PHY-619 ELECTRONICS II Credit Hours: 4(3-1)

FIELD EFFICT TRANSISTORS.

Junction FET; MOSFET; Operation and Construction; Biasing (Self Bias and Voltage Divider Bias); Insulated Gate Bipolar Junction Transistor (IGBT), Common Source and Common Drain Amplifiers (DC and AC Analysis, Input Resistance, Voltage and Current Gain, Frequency Response etc), Common Gate Amplifier, Class-D Amplifier, Multistage Amplifier (RC Coupled); Tuned RF Voltage Amplifiers.

THYRISTORS.

Four layer diode, Shockley Diode, The Silicon controlled rectifier, SCR Equivalent Circuit, SCR Applications, The Light-Activated SCR (LASCR), Half-Wave Power Control, Backup Lighting for Power Interruptions, Sawtooth Generator, Diac , Triac, Diac and Traic Applications, Silicon controlled switch, Uni-junction transistor

OSCILLATORS.

Introduction; Barkhausen Criterion; Feedback Oscillators; positive feedback condition for oscillation, startup conditions, RC Oscillators (Wien Bridge Phase, Shift Oscillator and T-twin oscillator); LC Oscillators (Colpitts, Crystal and Hartley Oscillators); Crystal controlled oscillators, Square-wave Oscillators; 555 Timer Oscillators.

OPERATIONAL AMPLIFIERS.

Introduction to Operational Amplifiers; The Differential Amplifier; Operational Amplifier and its Parameters; The Inverting and Non-inverting Circuits; Frequency Response; Feedback in Operational amplifier Circuits; Voltage follower Circuit; Operational amplifier Amplifier Applications (Comparator, Differentiator, Summing and Active Filter Circuits); Instrumentation Amplifiers.

PRACTICAL

1. To study the characteristics of a field Effect Transistor.
2. To design and assemble astable multivibartor and to study the variation of time period and wave shape.
3. To design and assemble a monostable multivibrator and to study the variation of time period and wave shape.
4. To design and assemble a bistable multivbrator to study the variation of time period and wave shape.
5. To design and assemble Hartley oscillator.
6. To design and assemble Colpitts oscillator.
7. To design and assemble a RC phase shift oscillator for a given operating frequency.
8. To study the basic parameters of an operational amplifier.
9. To study the adder circuit using the operational amplifier.
10. To study the integrator circuit using an operational amplifier.
11. To study the differentiator circuit using an operational amplifier.
12. To study the comparator circuit using an operational amplifier.
13. To study the Schmidt Trigger Circuit using an operational amplifier.
14. To study the frequency response of low pass filter.
15. To study the frequency response of high pass filter.
16. To study the frequency response of band pass filter.

RECOMMENDED BOOKS.

1. T.L.Floyd' Electronic Devices 9/e Prentice Hall (2012) Main Text Book.
2. A.P. Malvino' Electronic Principles' 7/e with CD-Rom Glencoe/ McGraw-Hill (2007).
3. D.A. Bell' Electronic Devices and Circuits'4/e Prentice Hall (1999).
4. C.J. Savant Jr. M.S. Roden and G.L Carpenter' Electronic Design Circuit and System' The Benjamin Publishing Co., California (1994).

PHY-620 - QUANTUM MECHANICS-I Credit Hours: 3(3-0)

Pre-requisites: Modern Physics I, II

INADEQUACIES OF CLASSICAL PHYSICS (Review of modern Physics)

Optical spectra (Ritz combination principle), Black body radiation with emphasis on ultraviolet catastrophe (Planck's radiation oscillators), The photoelectric effect, Einstein matter oscillators, The Compton effect, Review of physical optics (interference diffraction and polarization), Young's double slit experiment with emphasis on duality of matter wave, The Franck Hertz experiment, The Rutherford atom, Stationary states of atom, The correspondence principle and Bohr's atom, Spectroscopic series, Wilson Sommerfeld quantization rule, Shortcoming of old quantum theory, Pauli exclusion principle, Stern Gerlach experiment, Zeeman effect, De-Broglie hypothesis and Quantum mechanical atom, Analogies between optics and mechanics (Fermat's principle of least time, principle of least action)

MATHEMATICAL TOOLS OF QUANTUM MECHANICS

Introduction, The Hilbert space and Wave Function, Dirac Notation, Operators, Representation in Discrete Bases, Representation of Continuous Bases, Matrix and Wave Mechanics.

QUANTUM MECHANICS OF ONE-DIMENSIONAL POTENTIAL PROBLEMS

The Time Independent Schrödinger Equation;The Time-dependent Schrödinger Equation interpretation of the Wave function; Expectation Values and Differential operators: Solution of Schrödinger Equation for (a) Free Particle (b)Step Potential (c)Potential Barrier (Refection and Transmission Coefficients) (d) Square Well Potential (e)Infinite Potential Well and (f) Linear Harmonic Oscillator.

THE POSTULATES OF QUANTUM MECHNICS.

The State of System: Dynamic Variables and Operators: Expansion in Eigen functions; commuting and Non commuting Operators ; the Heisenberg Uncertainty Relations; Time Evolution of a System the Schrödinger and Heisenberg Pictures; Symmetry Principles and Conservation Laws.

ANGULAR MOMENTUM

Orbital Angular Momentum; The Eigenvalues and Eigen functions of L^2 and L_Z ; Matrix Representation of Angular Momentum Operators; Spin Angular Momentums; Total Angular momentum; The Addition of Angular momentums.

Recommended Books:

1. B.H Bransden and C.I Joachain" Quantum Mechanics" 2/e Pearson Education.
2. J.S Townsend" A Modern Approach to Quantum Mechanics" University Science Books, Sausaabto, California.
3. W.Greiner" Quantum Mechanics: An Introduction „Springer-Verlarg (1989)
4. R.L Liboff'Introduction Quantum Mechanics' 4/e Pearson Education (2003)
5. I. Bialynicki-Birula.M.Cieplak and J. Kaminski" Theory of Quanta' Oxford University Press (1992)
6. D.J Griffiths' Introductory Quantum Mechanies'2/e Pearson Education (2005)

7. S. Gasiorowiez‟ Quantum Physics'3/e John Wiley, New York (2003)
8. N. Zettili, "Quantum Mechanics: Concepts and Applications", John Wiley, 2nd ed. 2009.

PHY-621 ATOMIC AND MOLECULAR PHYSICS Credit Hours:3 (3-0)

Objective(s):
To provide an introduction to the structure and spectra of atoms and molecules. To prepare students for more advanced courses on Physics of Atoms, Molecules and Photons.

ATOMIC SPECTRA
Review of Bohr's Theory of Hydrogen and Hydrogen-Like Atoms; Franck-Hertz Experiment: Correspondence Principle; finite Mass Correction; Wilson-Summerfield Quantization Rules: Summerfield's Elliptic Orbits Relativistic correction.

VECTOR ATOM MODEL.
The Geomagnetic Ratio; The Bohr Magnetron; Quantum Numbers and their Physical Significance; Magnetic Moment of an Atom and Lande's Splitting Factor; Larmor's theorem, Stern-Gerlach Experiment.

ATOM IN EXTERNAL MAGNETIC AND ELECTRIC FIELD.
Introduction ; Normal and Anomalous Zeeman Effect; classical Theory of the Normal Zeeman Effect; Physics Significance; Quantum Theory of Normal and Anomalous Zeeman Effect; LS and JJ Coupling Paul's Exclusion Principle and the Periodic Table; Paschen-Back Effect; The Stark Effect, Fine Structure of Hydrogen Atom.

MOLECULAR SPECTRA
Introduction; Molecular Bonding; Diatomic Molecule as a Rigid Rotator; Rotational Energy Levels; Spectral Transition Probabilities and Selection Rules; Vibrational Spectra ; Determination of Bond Length, Vibrational-Rotational Spectra; Electronic Spectra; Electronic Spectra.

LASERS
Introduction; Absorption, Spontaneous Emission, Stimulated Emission; Significance of Einstein Continents: Pumping and Pumping Schemes (electrical and Optical), Laser Beam Characteristics; Resonators; Type of Lasers (He, Ne Laser, Ruby laser, CO_2 laser); Applications.

RECOMMENDED BOOKS

1. Anne, P. Thorn‟ Spectrophysics' 2/e Chapman and Hall (1988).
2. B.H. Bransden and C.j.joachain Physics of Atoms and Molecules' 2/e Pearson Education (2003).
3. R Eisberg & R Resnick „ Quantum Physics of Atoms, Molecules, Solids, Nuclei& Particles J. Willey (1985).
4. B.B. Land 'Lasers and Nonlinear Opties' 2/e New Age International Publishers, New Delhi (2001).
5. Robert L BrooksThe Fundamentals of Atomic and Molecular Physics (Latest Edi)

PHY-622 NUCLEAR PHYSICS Credit Hours: 4(3-1)

Objective(s):
To understand the nuclear structure using different nuclear models. To understand the nature of nuclear forces. To give understanding of radioactivity and nuclear reactions.

History: starting from bacqurel's discovery of radioactivity to chedwick's neutron.

Basic properties of nucleus: Nuclear size; mass; binding energy; nuclear spin; magnetic dipole and electric quadruple moment parity and statistics.

Nuclear forces: Yukawa's theory of nuclear forces, charge independence and spin dependence of nuclear force.

Nuclear models.

Introduction, liquid drop model, shell model, collective model,

Theories of radioactive decay

(a) alpha decay: - energy, range, ionization power and stopping power of alpha particles: quantum mechanical theory of alpha decay; alpha particle spectra, nuclear energy levels.

(b) beta decay:-energy velocity and range of beta particles; fermi theory of beta decay; neutrino hypothesis, non-conservation of parity.

(c) gamma decay: - energy range and nature of gamma rays; theory of gamma decay; classification of gamma decays; internal conversion.

Nuclear reactions.

Conservation laws of nuclear reactions; q-value and threshold energy of nuclear reaction; energy level and level width; cross section for nuclear reactions; bohr‟s theory of compound nucleus and its limitation; direct reaction; resonance reactions; breit-wigner one level formula.

Practical

1. To study the characteristics of Geiger-Muller tube and calculation of its dead time.
2. To investigate the characteristics of an ionization chamber.
3. To study the nature of radioactive decay i.e. Poisson distribution.
4. To determine the half-life a radioisotope (Radon-220)
5. Range of alpha particles in air using a solid- state detector.
6. Absorption coefficient of aluminum for beta particles.
7. Measurement of linear absorption coefficient of lead for gamma rays.
8. Verification of inverse square law for gamma rays.
9. Measurement of the gamma ray spectrum of a radioisotope.
10. **(10)** Use of a multi – channel analyzer.

RECOMMENDED BOOKS

1. E.Segre‟ Nuclei and Particles‟ Addison-Wesley (1977)
2. I. Kaplan‟ Nuclear Physics' Addison-Wesley (1962)
3. A.E.S. Green‟ Nuclear Physics' McGraw Hill (1955)
4. Kenneth S. Krane‟ Introductory to Nuclear Physics „john Willy (1987)
5. S.B. Patel „Nuclear Physics: An Introduction „New Age International (P) Ltd, New Delhi (1991)
6. S.N Ghoshal „Nuclear Physics' S. Chand and Co; New Delhi (1994)
7. W.E Burcham‟ Elements of Nuclear Physics' Longman (1979)

PHY-623 COMPUTATIONAL PHYSICS -I **Credit Hours: 3(3-0)**

Objective(s):

Introduction of computer languages. To know the use of computer in numerical analysis. Computer simulation and modeling.

Computer Languages: A brief introduction of the computer languages Matlab and known software packages of computation

The solution of nonlinear equations

Introduction; the bisection method; the method of false position (regula false method); newton-Raphson method; convergence of newton-raphson method; the secant method. The iteration method (x = g(x) form).

System of linear equations.

Introduction; gauss-jordan method; inversion of co-efficient matrix, cramer's rule, lu decomposition Crout's, cholesky & doolittle methods; iterative methods (jacobi and gauss-seidal methods).

Ordinary differential equation (ode).

Introduction, different methods to solve odes, picard's method, taylor series method, euler's Method, euler's modified method, huen's method, runge-kutta method (fourth order)

RECOMMENDED BOOKS

1. C.F Gerald & P.O Wheatley „ Applied Numerical Analysis' 7/e Pearson Education 2004.
2. S.C Chapra and R.P Canate‟ Numerical Methods for Engineers with Software and Programming.
3. Applications „ 4/e mcgraw-Hill (2002).
4. M. Iqbal‟ An Introduction to Numerical Analysis‟ llmi Kitab Khanna, Lahore (1991).
5. S.A Bhatti & N.A Bhatti‟ A First Course in Numerical Analysis with C++', Shaharyar Publishers,Lahore (2002).

PHY-624 QUANTUM MECHANICS -II Credit Hours: 3(3-0)

THE SCHRODINGER EQUATION IN THREE DIMENSIONS

Separation of Schrödinger Equation in Cartesian Coordinates (The Free Particle, The Three- Dimensional Box) Central Potential and Separation of the Schrödinger Equation in Spherical Polar Coordinates; the Free Particle the Three-dimensional Square Well Potential: Analysis of Hydrogen-like Atoms; The Three Dimensional Isotropic Oscillator.

APPROXIMATE METHODS

Time Independent Perturbation Theory for Non-degenerate and Degenerate Energy Levels; the Variational Method; the WKB Approximation; Time Dependent Perturbation Theory.

IDENTICAL PARTICLES AND SECOND QUANTIZATION

Many particle system, System of identical particles, Pauli Exclusion Principle, The Exclusion principle and periodic table

THEORY OF SCATTERING

Scattering Experiments and Cross-sections; Potential Scattering, the Method of Partial Waves and its Application; the Born Approximation.

RECOMMENDED BOOKS

1. A.P.Frech and E.F Taylor‟ An Introduction to Quantum Physics' Thomas Nelson (1978)
2. J.L. Powel and B. Crasemann‟ Quantum Mechanics' Addison-Wesley. Reading(1978)
3. R.H. Dicke‟ Introduction to Quantum Mechanics' Addison-WealeyReading(1966)
4. P.M. Mathews and K. Venkatcsan‟ A Textbook of Quantum Mechanics' Tata Mic GrawHill(1976)
5. N. Zettili‟ Quantum Mechanics: Concepts and Application 2/e John Wiley (2009)

PHY-625 COMPUTATIONAL PHYSICS -II Credit Hours: 3(3-0)

(1) INTERPOLATION

Introduction; Linear operators and Interrelationship between operators, Newton-Gregory's forward and backward difference interpolating polynomials; Gauss forward and backward interpolation (central difference formula); Newton's divided difference interpolation forUn-equally spaced arguments.Lagrange's formula

(2) NUMERICAL DIFFERENTIATION AND NUMERICAL INTEGARATION.

Introduction; Differentiation based onNewtown's forward and backward difference formula; Derivatives based on Lagrange's interpolating polynomial and Newton divided difference interpolation. Integration based on Rectangular rule and Trapezoidal rule, The Newton-Cotes integration formula (Simpson's $1/3^{rd}$rules, Simpson's $3/8^{th}$relation); Estimation of errors.

(3) STAISTICAL TECIINIQUES

Different types of mean, median and mod, Mean deviation; standard deviation; Curve fitting (Straight Line, parabola, and Exponential).Binomial and Poisson probability distribution.

RECOMMENDED BOOKS

1. J.H Mathews „ Numerical Methods for Mathematics, Science and Engineering '2/e Prentice Hall (1992)
2. Sher Muhammad Chaudhry, Introduction to Statistical Theory 'Part I lllmi Kitab Khana Lahore (2010).
3. J Mehdi" Statistical Methods' 6/e New International Publishers, New Delhi (2006).
4. G Shankar Rao 'Numerical Analysis' 3/e New Age International Publishers, New Delhi (2010).
5. B.S. Grewal' Numerical Methods in Engineering and Science' 7/e Khanna Publishers, Delhi (2005)

PHY-626 DIGITAL ELECTRONICS *Credit* Hours: 4(3-1)

Objective(s):

To learn the basics of digital electronics such as Boolean Algebra. To develop logic circuit using the Boolean Algebra. To understand the combinational, sequential logic circuits.

1) BOOLEAN ALGEBRA AND LOGICAL VARIABLES: Logic gates; Two Variable's Theorems; De Morgan's Theorems ; applications of Boolean Algebra; Logical Function; SOP and POS; K-maps and their Uses; Don't care Conditions; Different Binary Codes and their conversions (Gray code, Ex-3 Code, BCD Code, Weighted Code), Octal and Hexadecimal number system, their inter-conversion, concepts of logic, truth table, basic logic gates.

2) 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).

3) COMBINATIONAL LOGIC CIRCUITS: Half Adder; Full Adder; Half Subtractor; Full subactor; Encoders (octal to Binary, Decimal to Binary and Hexadecimal to Binary); Decoders (Binary to decimal, Binary to Octal and Binary to Hexadecimal); code converters (Binary to Gray, Gray to Binary etc); Multiplexers; De-multiplexers.

4) SEQUENTIAL LOGIC CIRCUITS: Basic Memory Elements; Flip-Flops (Set-reset Flip-Flop, D-type Flop, JK Flip-Flop and Master Slave Flip-Flop); Registers (Buffer Register, Shift Right Register, Shift Left register, Parallel in serial Out Register and Serial in Parallel Out Register); Counters (Asynchronous counter, Synchronous Counter , Up-down Synchronous Counter and Ring Counter)

RECOMMENDED BOOKS

1. Larry D. Jones' **Principles and Applications of Digital Electronics'** Macmillan Publishing company (1993)
2. T.C Bartec' **Digital System Design and Micro processor'** (NBF) Latest Edition
3. M. .Morris Mano **'Digital Logic and Computer Design** 'Prentice Hall Latest Edition
4. R.L Tokheim **'Digital Electronics: Principles and Applications'** 6/e, McGraw-Hill (2003)

5. T.L Floyd '**Digital Fundamental'** 10th /e Prentice Hall (2013)
6. Larry D. Jones **'Principles and applications of Digital Electronic**, Macmillan Publishing Company (1993)

Practicals:
(1) To demonstrate the operation and characteristics of TTL Logic Gate and to show how. It can be used to perform any three basic logic functions.
(2) To demonstrate the operation and characteristics of CMOS Logic Gate and to show how it can be used to perform any three basic logic functions.
(3) To demonstrate the operation of XOR Logic Gate and XNOR Logic To demonstrate the operation and characteristics of a set and rest (Latch) Flip Flop.
(4) To demonstrate the operation and characteristics of a D-type Flip Flop and storage register.
(5) To demonstrate the operation and characteristics of a binary counter.
(6) To demonstrate the operation of a BCD counter.
(7) To demonstrate the operation of Decoder gate.
(8) To demonstrate the operation of Decoder.
(9) To demonstrate the operation and characteristics of bipolar integrated circuit shift register.
(10) To demonstrate the operation of Multiplexer.

PHY-627 THESIS /PROJECT 6(6-0) / 6 (0-6)

Thesis/ Project will be allocated in the 7th semester. However, the credit hours for thesis will only counted in 8th semester.

OPTIONAL SUBJECTS FOR 8th SEMESTER

PHY-628 ENVIRONMENTAL PHYSICS-I Credit Hours: 4(3-1)

Objective(s):
To become familiar with the essentials of environment and Global climate. To learn to use spectroscopy for environments.
Introduction to the Essentials of Environmental Physics: The economic system, living in green house, enjoying the sun, Transport of matter, Energy and momentum, the social and political context.
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, flow in reverse, 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.

Topo Climates and Micro Climates: Effects of surface elements in flat and widely unduling areas, Dynamic action of seliq. Thermal action of selief.

Climatology and Measurements of Climate Factor: Data collection and organization, statistical analysis of climatic data, climatic indices, General characteristics of measuring equipment. Measurement of temperature, air humidity, surface wind velocity, Radiation balance, precipitation, Atmospheric Pressure, automatic weather stations.

PRACTICALS

1. Measurement of Electrical conductivity of Extract from Soil Saturated paste by use of digital conductivity Meter.
2. Measurmrnt of Viscosity of water.
3. Measurement of intensity of Noise by sound level meter.
4. Measurement of Air pollution by stochastic modeling techniques.
5. Measurement of conductivity of water.
6. Measurement of Relative humidity by using Dry and Wet bulb thermometers.
7. Measurement of total dissolved solids in water sample.
8. Preparation of EIA reports for Environmental protection.
9. Measurement of Different Atmospheric parameters.

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Recommended Books:

1. E.t Booker and R. Van Grondelle, "Environmental Physics", John Wiley,
3rd ed. 2011.
2. G. Guyot, "Physics of Environment and Climate", John Wiley, 1998.

PHY-629 NANO SCIENCE AND NANOTECHNOLOGIES-I* Credit Hours: 4(3-1)

Pre-requisite: Solid State Physics-II, Quantum Mechanics-II

Objective(s):

Introduce the concept and applications of nano sciences and nanotechnologies. Nano structures and nano technologies.

Introduction: Feynman talks on small structures, Nano scale dimension, Course goals and objectives.

Quantum Effects: Wave particle duality, Energy quanta, Uncertainty principle, De Broglie relation, Quantum Dots, Moore's law, tunneling.

Surfaces and Interfaces: Interfaces, Surface chemistry and physics, Surface modification and characterization, Thin Films, Sputtering, Selfassembled films.

Material Properties: Subatomic physics to chemical systems, types of chemical bonds, solid state physics / Material properties.

Tools and Instrumentation: STM, AFM, Electron Microscopy, Fluorescence methods, Synchrotron Radiation.

Fabricating Nano Structures: Lithography (photo and electron beam), MBE, Self-assembled masked, FIB, Stamp technology, Nano junctions.

Electrons in Nano Structures: Variation in electronic properties, free electron model, Bloch's theorem, Band structure, Single electron transistor, Resonant tunneling.

Molecular Electronics: Lewis structures, Approach to calculate Molecular orbitals, Donor Acceptor properties, Electron transfer between molecules, Charge transport in weakly interacting molecular solids, Single molecule electronics.

Nano Materials: Quantum dots, nano wires, nano photonics, magnetic nano structures, nano thermal devices, Nano fluidic devices, biomimetic materials.
Nano Biotechnology: DNA micro-arrays, Protein and DNA Assembly, Digital cells, genetic circuits, DNA computing.
Nanotechnology the Road Ahead: Nanostructure innovation, Quantum Informatics, Energy solutions.

PRACTICALS

1. Experiments on Natural nanomaterials
2. Experiments on Liquid crystals
3. Experiments on Colorimetric gold nanosensor
4. Experiments on Superhydrophobic materials
5. Experiments on Electropolishing, Electroplating, Anodizing and Etching.

Recommended Books:

1. S. Lindsay, "Introduction to Nanoscience", Oxford University Press, 2009.
2. C. Binns, "Introduction to Nanoscience and Nanotechnology (Wiley Survival Guides in Engineering and Science)", Wiley, 2010.

PHY-630 CUMMUNICATION SYSTEM Credit Hours: 4(3-1)

(1) SIGNALS AND SYSTEMS: Introduction to signals and systems; Types of signals; Types of systems; Signal representation; Review of Fourier series and transform. Fourier analysis of signals and systems

(2) MODULATION AND NOISE IN COMMUNICATION SYSTEMS. Modulation process and Modulation schemes; Analog and Digital types of Communication, baseband modulation and pass band modulation Noise in Communication Systems: Thermal noise; Calculation of Thermal Noise; Shot Noise; Signal to Noise Ratio; Noise Figure and Noise Temperature; Ideal Filter; Real Filter; Low-Pass, Band Pass, and High-Pass filters

(3) ANALOGUE COMMUNICATIONS. Communication Model. Linear Modulation in Time Domain and Frequency Domain; Amplitude Modulation and its Mathematical Form; Demodulation of AM Wave; Carrier Suppression: DSBSC and SSBSC Generation and Demodulation of DSBSC and SSBSC Signals; VSB, Angle Modulation Frequency and Pulse Modulation; Generation of FM and PM Waves; Demodulation of FM and PM; Pre-Emphasis

(4) PULSE AND DIGITAL COMMUNICATIONS. Pulse Modulation (PAM,PTM,PWM And PPM); Digital Modulation Techniques (ASK, PSK, DPSK QPSK); Sampling Process; Shannon's Theorem; Analogue to Digital Conversion: Pulse Code Modulation ; Delta Modulation ; Adaptive Delta modulation; Signal detection; Inter Symbol Interference, Nyquist theorem, Error Detection and Error Correction (Hamming codes, Convolution codes);

(5) INTRODUCTION TO CELLULAR COMMUNICATIONS. Introduction to Mobile communication; Evaluation of Mobile communications System cellular concept: Hand off Strategies ; Interference and Channel Capacity ; Cellular Phone Systems and Standards : Technical Features of AMPS and GSM;GSM System Architecture; GPRS; Multiple Access techniques; Frequency division Multiple Access(FDMA); Time Division Multiple Access (TDMA); Code Division Multiple Access (CDMA) ; Space Division Multiple Access (SDMA).

PRACTICALS

1. To design Amplitude Modulated circuit and calculate its modulation index.
2. To observe the demodulation of AM wave.
3. To construct a Frequency Modulated Circuit and to calculate the modulating index.
4. To observe the demodulation of FM wave.
5. Demodulation of FM using PLL circuit.
6. To construct a Balance Modulator circuit.
7. To construct a Pulse Amplitude Modulation and Demodulation circuit.
8. To study and implement PWM modulation using IC 555.
9. To construct a Pulse Position Modulation circuit.
10. To Study and implement ASK modulation and demodulation circuit.
11. To construct a FSK modulation and demodulation circuit.
12. To Study Pre Emphasis and De Emphasis circuit.
13. Experiment on Fourier analysis of Signals.
14. Experiments on Passive and Active Filters.

RECOMMENDED BOOKS

1. H. Taube and D.L. Schilling 'Principles of Communication Systems' 2/e McGraw-Hill (1986)
2. B.P Lathi' Modern Digital and Analog Communication Systems '3/e Oxford University (1998)
3. A.B Carlson' Communication Systems '4/e McGraw-Hill (2001)
4. S. Hay kin' Communication Systems '4/e John Wiley (2001)
5. W. Tomasi' Electronic Communication Systems: Fundamentals through Advanced '6/e Pearson Education (2005)
6. L.E Frenzel 'Principles of Electronic Communication Systems' 3/e, McGraw-Hill (2007)
7. G.Kennedy and B. Davis 'Electronic Communication Systems '4/e Glencoe (1993)
8. R. Stele and L. Hanzo (Eds.)' Mobile Radio Communications' 2/e John Wiley (1999)

PHY-631 INTRODUCTION TO RENEWABLE ENERGY Credit Hours: 4(3-1)

OBJECTIVE

Students are introduced to different types of renewable energy resources by engaging in various activities to help them understand the transformation of energy (solar, water, nuclear, biomass and wind) into electricity. Students explore the different roles engineers who work in renewable energy fields have in creating a sustainable environment – an environment that contributes to greater health, happiness and safety.

CONTENT

Promising renewable energy sources, their potential availability and present status, existing technologies and availability, solar energy: Sun-Earth relationship, solar geometry, sun path and solar irradiance, solar spectrum. Solar constant, atmospheric effects, global distribution, effects of tilt angle, daily and seasonal variations, resource estimation. Extraterrestrial, global, direct, diffused radiation, Flat plate collectors, their designs, heat transfer, transmission through glass, absorption transmission of sun energy, selective surfaces, performance, and efficiency, Photovoltaic: PV effect, materials, solar cell working, efficiencies, different types of solar cells, characteristics, (dark, under illumination), efficiency limiting factors, power spectral response, fill factor, temperature effect; PV systems, components, modules, arrays, controllers, inverters, storage, PV system sizing, performance and applications, Wind: Global distribution, resource assessment, wind speed, height and topographic effects, power extraction for wind energy conversion, wind mills, their types, capacity, properties, wind mills for water lifting and power generation, environmental effect.,

Hydropower: Global resources, and their assessment, classification, micro, mini, small and large sources principles of energy conversion; turbines, their working and efficiency for micro to small power systems, environmental impact, Biogas: Biomass sources; residue, farms, forest. Solid wastes; agricultural, industrial and municipal wastes etc.; applications, traditional and nontraditional uses: utilization, process, gasification, digester, types, energy forming, Environment issues, Geothermal: Temperature variation in the earth, sites, potentials, availability, extraction techniques, applications; water and space heating, power generations, problems, environmental effects, nuclear: Global generations of reserves through reprocessing and breeder reactors, growth rate prospect of nuclear fusion, safety and hazards issue.

Practical:

1. Measurement of power of Solar cell
2. Measurement of Color effect on absorption of solar radiation
3. Study the plate flat collectors
4. Study of different parameter of solar cooker.
5. Wind speed and direction measurement.

BOOKS RECOMMENDED

1. Manfred Grathwhol. World Energy Supply: Resources, Technologies and Prospective, Walter deGruyter-Berlin, Latest edition
2. J.W Twidell and A.D. Weir. Resources, E & F.N. Spon Ltd, London, Latest edition
3. M Iqbal. An Introduction to Solar Radiation, Academic Press, Canada, Latest edition
4. Simon Roberts. A Practical Guide to Solar Electricity, Prentice Hall, Latest edition
5. Martin A G. Solar cells: Operating Principles, Technology, & System Application, Prentice Hall, Latest edition
6. T.J. Jansen. Solar Engineering Technology, Prentice Hall, Latest edition
7. Daniel H' Wind Power. A Book on Wind Energy Conversion System, Litton Educational Press, Latest edition

PHY-632 APPLIEDE SOLID STATE PHYSICS* Credit Hours: 4(3-1)

Magnetism in solids

Introduction and Terminologies. Magnetic non-Magnetic materials, magnetic dipole, atomic magnetic moment, Types of Magnetic materials, Diamagnetism, (classical and quantum explanation), Paramagnetism (Langevine's classical theory, Quantum theory), adiabatic demagnetization, Ferromagnetism, Antiferromagnetism, Weiss theory of Ferromagnetism, concept of domains and Hysteresis, Paramagnetic resonance, Nuclear magnetic resonance, Ferromagnetic resonance, Spin Waves (Basic concepts)

Superconductivity

Introduction and historical background, electrical resistivity, Meissner effect Perfect Diamagnetism, Supercurrents and penetration depth, Critical temperature, Type-I and Type-II superconductors, London Equation, Branden- Cooper- Schrieffer theory (Qualitative Approach). Josephson's effect, High temperature superconductors.

Practical:

1. To study the electrical conductivity in solids.
2. To study the Ferromagnetic Hysteresis.

3. To study the Hall effect in P-type germanium.
4. To study the Band gap of Germanium.

Recommended Books:

1. Introduction to Solid State Physics, Charles Kittle, 8th Edition, Wiley
2. Solid State Physics, Neil W Ashcroft and David M, Saunders College Publishing
3. Elementary Solid State Physics, M A Omar, 2nd edition, Pearson educations
4. Physics of solids, Wert and Thomson, 2nd edition. McGraw-Hill.
5. Fundamentals of Solid State Physics, J R Christman, Wiley and Sons, New York.

PHY-633 RADIATION SAFETY AND NUCLEAR REACTOR DESIGN Credit Hours: 4(3-1)

Basic of radiation, radiation doses, effects of radiation and radiation protection principles, dose assessment and dose constraints, dose guidance and interventional levels, applications of radiation in medical, industry, agriculture and research purposes, Detailed description of various basic and advance radiation applications in medical, industrial, agriculture, and research.

Nuclear reactions, chain reaction, controlled chain reaction, neutron flux and neutron absorption, radiation dosimerty, exposure and contamination and their control, emergency preparedness and response mechanism, radioactive waste management processes, environmental monitoring, radiation detection techniques and measurement process, inspection and authorization for radiation safety, case studies, gamma spectroscopy, categorization of radioactive sources.

National and International legal and Regulatory Framework for the nuclear and radiation safety and security including convention, resolutions, treaties, guidance document, national ordinance and regulations.

Basic of Reactor design, operational principle of nuclear power plant, safety of nuclear power plant operation, safe use of nuclear energy, relevant international codes and standards for the safe use of nuclear energy, safety and security culture.

Practical

1. TI based NaI gamma Spectroscopy,
2. HPGe spectrometer and associated analytical softwares,
3. Spectrum analysis and categorization of nuclear and other radioactive materials, Environmental sampling and analysis techniques

RECOMMENDED BOOKS

1. E.Segre‟ Nuclei and Particles‟ Addison-Wesley (1977)
2. Kaplan‟ Nuclear Physics' Addison-Wesley (1962)
3. A.E.S. Green‟ Nuclear Physics' McGraw Hill (1955)
4. Kenneth S. Krane‟ Introductory to Nuclear Physics „john Willy (1987)
5. S.B. Patel „Nuclear Physics: An Introduction „New Age International (P) Ltd, New Delhi (1991)
6. S.N Ghoshal „Nuclear Physics' S. Chand and Co; New Delhi (1994)
7. W.E Burcham‟ Elements of Nuclear Physics' Longman (1979)

PHY-634 MECHATRONICS Credit Hours: 4(3-1)

(1) INTRODUCTION:

Introduction, DC motor speed controller, stepper motor speed and position controller, DC motor position and speed controller.

(2) SENSORS

Position and speed measurement (Proximity Sensors and Switches, Potentiometer, Linear Variable Differential Transformer, Digital Optical Encoder), stress and strain measurement (Electrical Resistance Strain Gage, Measuring Resistance Changes with a Wheatstone Bridge, Measuring Different States of Stress with Strain Gages, Force Measurement with Load Cells), temperature measurement (Liquid-in-Glass Thermometer, Bimetallic Strip, Electrical Resistance Thermometer, Thermocouple), vibration and acceleration measurement (Piezoelectric Accelerometer), pressure and flow measurement, semiconductor sensors and microelectromechanical devices.

(3) ACTUATORS

Electromagnetic principles, solenoids and relays, electric motors, dc motors, electronic control of a permanent magnet dc motor, stepper motors, stepper motor drive circuits, hydraulics (hydraulic valves, hydraulic actuators), pneumatics (pneumatics cylinder, pneumatics muscle and their control)

(4) Digital Control

Arduino Uno, Arduino nano, Arduino mega, ESP32, Bluetooth module (HC-05/06), Introduction to scratch programing, introduction to mBlock, mBlock for programing Arduino (Uno, Nano, Mega, and ESP32). Programing for sensors , Programing for motors (Stepper, Servo and DC).

PRACTICAL:

1) Experiments on different types of Temperature sensors and signal conditioner.
2) Experiments on linear position sensor and conditioner
3) Experiments on angular position and speed measurement sensor
4) Experiments on Pressure sensors
5) Experiments on weight sensors
6) Experiments on water level and pressure
7) Experiments on stepper and DC motors
8) Experiments on vacuum level sensors and actuators
9) Experiments on industrial interface card using visual designer
10) Experiments on programmable logic controller (PLC)
11) Experiments of Robotic Arm
12) Experiments on accelerometer and velocity transducer

RECOMMENDED BOOKS

1 David G. Alciatore and Michael B. Histand. "**Introduction to Mechatronics and Measurement Systems**", Fourth Edition, (Mc Graw Hill 2012)

2. Robert H. Bishop **"Mechatronics an introduction**" , First Edition, (Taylor & Francis 2006)

PHY-635 MICROPROCESSORS AND MICROCONTROLLERS Credit Hours: 4(3-1)

(1) MICROPROCESSORS

Basic computer (central processing unit, memories and storage, input output ports, busses, computer software, the computer system), introduction to microprocessor, the 8086 microprocessor internal Architecture (bus interface unit, execution unit, instruction queue, internal busses), 8088 microprocessor Architecture, overview of intel microprocessors family.

(2) MICROPROCESSOR PROGRAMING

Addressing modes, Data transfer instructions, Arithmetic instruction, Bit manipulation instructions, loops and jumps, String instructions, subroutine and Interrupts, process control instructions.

(3) DIGITAL SIGNAL PROCESSING

Introduction to digital signal processing (DSP), applications of DSP, converting analog signal to digital (sampling and filtering, Holding the Sampled Value, conversion, quantization), Analog to digital converter (Flash analog to digital converter, Dual -Slope Analog to digital converter, Successive- Approximation analog to digital converter), Digital to analog conversion (Weighted input digital to analog converter, R/2R ladder digital to analog converter).

(4) MEMORY AND STORAGE.

Introduction to memory system (memory units, memory array, memory address and capacity, write and read operation), The RAM Family, Static RAM unit cell, Asynchronous Static RAM organization, synchronous Burst SRAM organization, Cache Memory, DRAMs storage cell, Basic organization of DRAM, types of DRAM, ROM, internal ROM organization, PROMs and EPROMs, Flash memories (Flash memory cell, Flash memory operation, Basic flash memory array), Memory expansion (Word length Expansion, word capacity Expansion), SIMMs and DIMMs, Special types of memories (FIFO memories, LIFO memorie), Magnetic and optical Storage (Magnetic Hard Disks, Floppy Disks, CD-ROM)

5) INTRODUCTION TO MICROCONTROLLERS: Arduino Uno, Arduino nano, Arduino mega, ESP32, Bluetooth module (HC-05/06), Introduction to scratch programing, introduction to mBlock, mBlock for programing Arduino (Uno, Nano, Mega, and ESP32). Programing for sensors (ultrasonic), Programing for motors (Stepper, Servo and DC).

RECOMMENDED BOOKS.

1. T.L Floyd ‘ Digital Fundamental ‘ 9/e Prentice Hall (2006)
2. Barrey B. Brey ‘ The Intel Microprocessors 8086/8088, 80186/81088, 80286, 80386, 80486, Pentium and Pentium Pro Processor , Pentium 2, Pentium 3, Pentium 4: Architecture, Programming and Interfacing ‘ 7/e Prentice Hall (2005)
3. Douglas V. Hall ‘ Microprocessors and interfacing: Programming and Hardware’ 2/e Glance(1992)
4. M. Rafiquzaman’ Microprocessors: Theory & Applications with 68000/68020 & Pentium ‘J Wlley, 2008.
5. C.M Gilmore’ Microprocessors : Principles and Applications ‘ McGraw-Hill (1989)