B.Sc. (Physics, Chemistry, Mathematics)

18CHY102 Atomic Structure, Chemical Bonding and Analytical Chemistry
3-0-2 4

Objectives: To develop an understanding of principles of Atomic structure, Bonding and Analytical Chemistry. To develop an understanding of the Periodic trends and to relate the properties of compounds in terms of their chemical bonding.

COURSE CONTENT

Unit I:

Atomic Structure: Bohr model of hydrogen atom, Bohr’s equation for the energy of electron in hydrogen atom, the hydrogen spectrum, limitations of Bohr theory, photoelectric effect, idea of de Broglie matter waves, Heisenberg’s uncertainty principle and its significance, Schrödinger wave equation (derivation not expected), wave functions, significance of \( \psi \) (psi) and \( \psi^2 \), atomic orbitals, Nodal planes in atomic orbitals, quantum numbers (n, l, m), Zeeman effect, Stern-Gerlac experiment, spin quantum number (s), shapes of s, p and d orbitals. Aufbau and Pauli’s exclusion principles, Hund’s rule, energy level diagram of a multielectron atom, concept of effective nuclear charge, Slater’s rules and applications, Electronic configuration of atoms.

Unit II:


Unit III:

Chemical Bonding -I: Ionic bond: Factors that favor the formation of ionic bonds, Lattice energy, Born-Lande’s equation (no derivation), Born-Haber cycle, setting up of Born-Haber cycle for 1:1 ionic solids. Numerical calculations of LE and EA based on Born-Haber cycle for 1:1 ionic solids, uses of Born-Haber cycle. Role of lattice energy and hydration energy and their importance in the context of stability and solubility of ionic solids. Covalent bond: Factors favoring the formation of covalent bond (ionization energy, electron affinity, electronegativity, nuclear charge, inter nuclear distance and number of valence electrons). Valence bond approach – explanation with examples to illustrate valence bond approach. Sigma and Pi bonds. Fajan’s rules of polarization and their explanation. Bond length, bond order, bond energy and their significance, polarity of covalent bonds, polar and non-polar molecules, Dipole moment and polarity of molecules to be explained by taking HCl, CO\(_2\), CCl\(_4\) and H\(_2\)O as examples.
Unit IV:
Chemical Bonding –II: Hybridization-directional property and geometry of sp, sp², sp³, sp³d and sp³d² hybrid orbitals with examples respectively. VSEPR theory. Coordinate bond: with examples. Molecular Orbital Theory: An elementary account of MOT, linear combination of atomic orbitals (no mathematical approach). Bonding and antibonding molecular orbitals, conditions for the combination, energy levels of molecular orbitals, Molecular orbital structures and bond orders of simple molecules and ions, prediction of magnetic properties.

Unit V:
Analytical Chemistry
Statistical treatment of results of quantitative analysis: Classification of errors, accuracy, precision, minimization of errors (calibration of apparatus, running of blank determination, running parallel determination to be mentioned), significant figures and computation, mean and standard deviation (explanation with an example), distribution of random errors (explanation with the help of curve), reliability of results (F-test and t-test).
Text books:

References:
1. C. N. R. Rao, University General Chemistry, Macmillan, India
6. G. D. Christian, Analytical Chemistry, John Wiley and Sons

PRACTICALS
VOLUMETRIC ESTIMATIONS
1. Estimation of Sodium Carbonate and Sodium Bicarbonate in a mixture.
2. Estimation of Ammonia in Ammonium Salt by Back Titration.
3. Estimation of Ferrous ions using Potassium Permanganate
4. Estimation of Oxalic acid using Potassium Permanganate
5. Estimation of Ferrous ions Using Potassium Dichromate with Internal & External Indicators.
7. Estimation of Copper in a Copper salt by Iodimetry
8. Standardisation of EDTA solution using Zinc Sulphate and determination of Mg or Ca

Reference:
A Text Book of Quantitative Inorganic Analysis, A. I. Vogel

18CHY112 Nuclear Chemistry, States of Matter and Chemistry of S and P Block Elements 3-0-2 4

Objectives: To enable students to develop an understanding of properties of Solids, Liquids and Gases, understand the shapes of molecules in terms of symmetries and to relate the properties of the matter in solid state to the structure, develop an understanding of the periodic trends, preparations, properties and uses of s and p block elements and their compounds.

COURSE CONTENT
Unit I:
Nuclear Chemistry: Nuclear particles, nuclear forces, nuclear size, nuclear density, stability of nucleus, binding energy, packing fraction, n/p ratio. Nuclear models – liquid drop model and shell model. Natural radioactivity, modes of decay, decay constant, half-life period, average life, radioactive equilibrium, Geiger-Nuttall rule, units of radioactivity, radiation dosage. Induced radioactivity, nuclear reactions induced by charged projectiles, neutrons and \( \gamma \) rays, fission reactions, fusion reactions, spallation reactions, preparation of transuranic elements, Q values of nuclear reactions. Fertile and fissile isotopes, chain reaction, stellar energy. Application of Radioactivity and Radio isotopes as tracers in analysis, Reaction mechanism through tracer chemistry in medicines, in biological field, in agriculture and industry.

Unit II:
Gases: Kinetic molecular model of gases: pressure of an ideal gas, derivation of gas laws, Maxwell’s distribution of velocities – molecular velocities (average, root mean square and most probable velocities). Collision diameter, mean free path, viscosity of gases – temperature and pressure dependence. Relation between mean free path and coefficient of
viscosity. Barometric distribution law, Law of equipartition of energy, degrees of freedom and molecular basis of heat capacities.


**Unit III:**

**Liquids:** Intermolecular forces in liquids (qualitative idea only) - viscosity, the viscometer method


**Unit IV:**

**Solids:** Elements of symmetry – plane, axis and centre, elements of symmetry in cubic crystals,

law of rational indices – Weiss and Miller indices, lattice planes in cubic crystals. Crystal lattice and unit cell, types of Lattice – Bravais lattices, X-Ray diffraction and Bragg’s Law (to be derived), determination of crystal structure of rock salt by rotating crystal method using Bragg’s spectrometer, application of X-ray studies – distance between lattice planes, density of crystals, determination of Avogadro Number (numerical problems on applications).


**Unit V:**

**Chemistry of s and p block elements:** General characteristics of elements- Electronic configuration, oxidation state, inert pair effect, melting points and boiling points, densities, metallic character, nature of bonds formed, hydration of ions and ionic conductance in solution (only alkali metals), flame colouration. Reactivity, electrode potentials and reducing properties, reaction with water. Compounds – Oxides and peroxides-formation and reaction with water, basic character of oxides and hydroxides. Carbonates-thermal stability. Reasons for anomalous behaviour of Li and Be, diagonal relationship of Li and Mg. Hydrides-classification of boron hydrides, diborane-preparation from BCl$_3$, properties(reactions with
ammonia and Lewis acid properties) and structure (based on VBT). Halides- comparison of Lewis acid character of boron trihalides. Catenation, allotropic forms of carbon- diamond, graphite and fullerenes (C_{60}) and their structures, carbon nanotubes (brief mention without structural details). Silicates- Classification, structures of ortho and pyrosilicates.

Text books:
2. B. R. Puri, L. R. Sharma, M. S. Pathania, Elements of Physical chemistry, Vishal Pub. Co. Jalandhar,

References:
1. H. J. Arnikar, Essentials of Nuclear Chemistry, New Age
2. R. Gopalan, Elements of Nuclear Chemistry, Vikas Publ. House
3. K. L. Kapoor, A Textbook of Physical chemistry, Volumes 1, Macmillan India Ltd
5. F. A. Alberty and R J Silby, Physical Chemistry, 3 rd Edn, John Wiley

PRACTICALS
1. Systematic semi-micro qualitative analysis of a mixture of two simple salts (with no interfering radicals). Constituent ions in the mixture to be restricted to the following.
   Anions: HCO_3^-, CO_3^{2-}, SO_3^-, Cl^-, Br^-, NO_3^-, SO_4^{2-}, BO_3^{3-}, PO_4^{3-}
   Cations: Pb^{2+}, Bi^{3+}, Cd^{2+}, Al^{3+}, Fe^{2+}, Fe^{3+}, Mn^{2+}, Zn^{2+}, Ba^{2+}, Ca^{2+}, Sr^{2+}, Mg^{2+}, K^+, Na^+ and Mg^{2+}
   Note: Mixtures requiring elimination of borate and phosphate to be avoided. Combination of anions of 2nd group shall be avoided. The combination of two cations in the mixture should belong to different groups.
2. Determination of density by specific gravity bottle and viscosity of the given liquid by Ostwald’s viscometer
3. Determination of density by specific gravity bottle and surface tension of the given liquid by stalagmometer.
4. Determination of refractive index of pure liquids and mixtures.

Objectives:
To enable students to develop an understanding of chemistry of hydrocarbons and their halogenated derivatives.

Unit I:

Unit II:

Unit III:
Aliphatic Hydrocarbons - Alkanes: Methods of formation (with special reference to Wurtz reaction, Kolbe reaction, Corey-House reaction and decarboxylation), physical properties and chemical reactions of alkanes (halogenation, nitration, sulphonation, oxidation and isomerisation reactions) Mechanism of free radical halogenation of alkanes: orientation, reactivity and selectivity. Cycloalkanes: methods of formation (from acetoacetic ester / malonic ester and Dieckmann reaction), chemical reactions (halogenation), Baeyer’s strain theory and its limitations. Ring strain in small rings (cyclopropane and cyclobutane), theory of strainless rings.

**Unit IV:**


**Unit V:**

**Alkyl and Aryl Halides:** A study of Alkyl halides highlighting its synthetic applications. Nomenclature and classes of alkyl halides, methods of formation, chemical reactions. Mechanisms of nucleophilic substitution reactions of alkyl halides S_N2 and S_N1 reactions with energy profile diagrams. Polyhalogen compounds: chloroform, carbon tetrachloride. Aryl halides: Methods of formation of aryl halides, nuclear and side chain reactions. The addition- elimination and the elimination-addition mechanisms of nucleophilic aromatic substitution reactions. Relative reactivities of alkyl halides vs allyl, vinyl and aryl halides. Synthesis and uses of DDT and BHC

**Text books:**


**References:**

PRACTICALS

COURSE CONTENT:

   - Acids
   - Alcohols
   - Aldehydes
   - Amides
   - Amines
   - Halogenated hydrocarbons
   - Hydrocarbons
   - Ketones
   - Nitro compounds
   - Phenols

18CHY211 Thermodynamics, Chemical Equilibrium and Electrochemistry 3-0-2 4

Objectives: To develop an understanding of Thermodynamics, Chemical Equilibrium and Phase Equilibria, Solutions and Electrochemistry.

Unit I:


Third law of thermodynamics: statement and significance.


Unit II:

Unit III:

Unit IV:
Calculation of thermodynamic quantities of cell reactions (G, H and K), Chemical cells with and without transport.

Unit V:

Text books:

References:
1. P. Atkins and J Paula, The elements of Physical chemistry, 7th edn., Oxford University Press,

PRACTICALS
1. Determination of heat of neutralization of acids and bases.
2. Verification of Hess’s law of constant heat summation.
3. Determination of solubility of sparingly soluble salt at various temperature, calculation of enthalpy of solution.
4. pH titration of acid versus base (observation of change in pH).
5. Determination of dissociation constant of a weak acid.
6. Determination of solubility product constant (Ksp) of a sparingly soluble salt.
7. Determination of percentage composition of NaCl by critical solution temperature method (phenol-water system).
8. Determination of distribution coefficient of benzoic acid between water and toluene or acetic acid between water and 1-butanol.
Objectives: To develop an understanding of Transition elements, Coordination compounds, Chemical kinetics, Spectroscopy and Surface Phenomena

Unit I:

Chemistry of d and f block Elements: General characteristics of d-block elements with special reference to electronic configuration, oxidation states, variable valency, metallic character, color, magnetic properties, catalytic properties and ability to form complexes. Comparison of the properties of second and third transition series with first transition series. Chemistry of lanthanides – electronic structure, oxidation states, lanthanide contraction, consequences of lanthanide contraction, magnetic properties, spectral properties and separation of lanthanides by ion exchange and solvent extraction methods (Brief study). Chemistry of actinides – electronic configuration, oxidation states, actinide contraction, position of actinides in the periodic table, comparison with lanthanides in terms of magnetic properties and spectral properties (Brief study). Extraction of Thorium, Uranium and Plutonium from burnt nuclear fuels.

Unit II:

Coordination Compounds: Werner’s coordination theory and its experimental verification, nomenclature of coordination compounds, isomerism in coordination compounds, valence bond theory of transition metal complexes. Limitations of VBT. Elementary treatment of crystal field theory, splitting of d-orbitals in square planar, tetrahedral and octahedral complexes, factors affecting crystal field parameters, Explanation of magnetic behaviour and colour of complexes using CFT, effective atomic number concept. Metal carbonyl, 18 electron rule, Preparation, structure and reactions of Ni(CO)₄, Fe(CO)₅ and V(CO)₆, nature of bonding in metal carbonyls.

Unit III:


Unit IV:

Chemical Kinetics: Chemical kinetics and its scope, rate of a reaction, factors influencing the rate of a reaction – concentration, temperature, pressure, solvent, light, catalyst. Concentration dependence of rates, mathematical characteristics of simple chemical reactions – zero order, first order, second order, pseudo order, half life and mean life. Determination of the order of reaction – differential method, method of integration, method of half-life period and isolation method.
Radioactive decay as a first order phenomenon. Effect of temperature on rate of reaction, Arrhenius equation, concept of activation energy. Simple collision theory based on hard sphere model, transition state theory (equilibrium hypothesis). Expression for the rate constant based on equilibrium constant and thermodynamic aspects

**Unit V:**

**Spectroscopy:** UV and Visible spectroscopy: Introduction, absorption laws, instrumentation, formation of absorption bands, types of electronic transitions, chromophores, auxochromes, absorption and intensity shifts, solvent effects, Woodward – Fieser rules for calculating absorption maximum in dienes and α,β-unsaturated carbonyl compounds. IR spectroscopy: Introduction, theory of molecular vibrations, vibrational frequency, factors influencing vibrational frequencies, finger print region and applications of IR spectroscopy. NMR spectroscopy: Introduction, instrumentation, number of signals, position of signals (Chemical shift), shielding and deshielding effects, factors influencing chemical shifts- inductive effect, anisotropic effect and hydrogen bonding. Splitting of signals, spin-spin coupling, chemical exchange and coupling constant. Structural determination of simple organic compounds using UV, IR and NMR spectral data.

**Text books:**

**References:**

**18CHY311 Functional Groups, Heterocyclic Compounds and Natural Products**

**Objectives:**
To develop an understanding of Natural Products, Alcohols and Phenols, Carbonyl Compounds, Organic Compounds of Nitrogen and Heterocyclic Compounds

**Unit I:**

**Alcohols and Phenols:** Monohydric alcohols: Nomenclature, methods of formation (reduction of aldehydes, ketones, carboxylic acids and esters). Hydrogen bonding, Acidic nature. Reactions of alcohols (oxidation, esterification, dehydration). Dihydric alcohols: Nomenclature, methods of formation (from alkenes and alkyl dihalides), chemical reactions of vicinal glycols - oxidative cleavage [Pb(OAc)₄ and HIO₄] and Pinacol-pinacolone rearrangement. Trihydric alcohols: Nomenclature and methods of formation (from alkenes and alkenals), chemical reactions of glycerol (with nitric acid, oxalic acid and HI). Phenols: Nomenclature, structure and bonding, Preparation of phenol, resorcinol and 1 and 2-

**Unit II:**


**Unit III:**


**Unit IV:**

**Heterocyclic Compounds:** Introduction, methods of formation of five membered heterocycles – furan, thiophene and pyrrole. Molecular orbital picture and aromatic characteristics of pyrrole, furan, thiophene and their chemical reactions with particular emphasis on the mechanism of electrophilic substitution. Six membered heterocycles: methods of formation of pyridine, mechanism of nucleophilic substitution reactions in pyridine derivatives. Comparison of basicity of pyridine, piperidine and pyrrole.
Introduction to condensed five and six-membered heterocycles, preparation and reactions of Indole, quinoline and isoquinoline with special reference to Fischer indole synthesis, Skraup synthesis and Bischler-Napieralski synthesis. Mechanism of electrophilic substitution reactions of indole, quinoline and isoquinoline.


Text books:

References:
3. I.L. Finar, Organic Chemistry - Volume I & II - Pearson Education

18CHY351 ENVIRONMENTAL CHEMISTRY 3 0 0 3

Objectives:
To study environmental management and impact assessment.
To understand the toxic effects of pollutants.
To understand the harmful effects of air, water, and soil pollution
To study about effluent and waste management.

Unit I:
**Chemical toxicology:** Toxicity-effects, toxic chemicals in the environment, impact of toxic chemicals on enzymes, biochemical effects of As, Cd, Pb, Hg, Co, NOx, SO₂, O₃, PAN, CN, pesticides, carcinogenic substances.

Unit II:
**Air pollution:** Primary pollutants, hydrocarbons-photochemical smog, particulates, radioactivity, effects of atmospheric pollution -acid rain, ozone layer depletion. Indoor air pollution. Effect of electric and magnetic fields in the environment Air pollution accidents – Bhopal and Chernobyl.

Unit III:
**Water pollution:** Pollution of fresh water, ground water and ocean. Thermal pollution. Sampling and measurement of water quality – odour, colour, EC, turbidity, TDS, salinity, COD, BOD, DO, coliform, pH, acidity, CO₂, alkalinity, hardness, NO₃⁻, NO₂⁻, NH₃, phosphate, fluoride, chloride, cyanide, sulphide, sulphate and metals- As, Cd, Fe, Pb, Hg, SAR, WQI. Water quality parameters and standards. Waste water treatment techniques.

Unit IV:

Unit V:
**Lithosphere:** Composition, reactions in soil. Wastes and pollutants in soil. Sampling procedures and analysis of soil- cation exchange capacity, lime status, lime requirement, gypsum requirement, pH, N, P, K, S, Ca, Mg. Management of solid waste

Text books:
A. K. De, Environmental Chemistry, New age International Ltd.
S. S. Dara, A Textbook of Environmental chemistry and pollution control, S.Chand & Company Ltd.

References:

Objectives:

To understand about the pros and cons of using processed food stuff.
To understand the difference between the various types of soaps, synthetic detergents and cosmetics.
To understand the about the environmental hazards of plastics.
To understand the about the different bio pesticides.

Unit I:

Unit II:
Cosmetics- Introduction, classification – bathing oils, face creams, toilet powder, skin products, dental cosmetics, hair dyes, shaving cream, shampoo, general formulation of each type. Toxicology of cosmetics.

Unit III:

Unit IV:

Unit V:

Drugs : Chemotherapy- types of drugs- analgesics, antipyretics, antihistamines, antacids tranquillisers, sedatives, antibiotics.

Text books:
A. K. De, Environmental Chemistry, New age International Ltd.
S. S. Dara, A Textbook of Environmental chemistry and pollution control, S.Chand & Company Ltd.

References:
3. B.K. Sharma. Industrial Chemistry
4. CNR Rao- Understanding chemistry, Universities Press.
10. Singh, V.K Kapoor, Organic Pharmaceutical Chemistry

18CHY353 FORENSIC SCIENCE 3 0 0 3

Objectives:
To learn Crime investigation through diagnosis of poisoning and post mortem.
To acquire knowledge about explosions, the causes (gelatin sticks, RDX etc) and the security measures.
To understand the methods of detecting forgery in bank and educational records.
To understand the chemical methods used in crime investigation. (Medical aspects).

Unit I:
Poisons: Poisons-types and classification-diagnosis of poisons in the living and the dead – clinical symptoms - postmortem appearances. Heavy metal contamination (Hg, Pb, Cd) of sea foods-use of neutron activation analysis in detecting Arsenic in human hair. Treatment in cases of poisoning - use of antidotes for common poisons.

Unit II:

Unit III:
Forgery and Counterfeiting Documents: Different types of forged signatures-simulated and traced forgeries - inherent signs of forgery methods - writing deliberately modified uses of ultraviolet rays - comparison of type written letters - checking silver line water mark in currency notes - alloy analysis using AAS to detect counterfeit coins - detection of gold purity in 22 carat ornaments - detecting gold plated jewels - authenticity of diamond.

Unit IV:
Tracks and Traces: Tracks and traces - small tracks and police dogs-foot prints - casting of foot prints residue prints, walking pattern or tyre marks - miscellaneous traces and tracks - glass fracture - tool mark paints – fibres. Analysis of biological substances - blood, saliva, urine and hair- Cranial analysis (head and teeth) DNA. Finger printing for tissue identification in dismembered bodies -Detecting steroid consumption in athletes and race horses.

Unit V:

Text books:
1. T.H.James, Forensic Sciences, Stanley Thornes Ltd.

References:

18CHY354 NANOCHEMISTRY AND NANOTECHNOLOGY 3 0 0 3

Objectives:
To study History, terminology and scales of nano systems, Synthesis and characterisation of nano systems
Electrical and optical properties of nano systems and Applications of nanomaterials.

**Unit I:**

**History:** Terminology- scales of nano-systems- nanoparticles: introduction-atoms to molecules-quantum dots shrinking of bulk materials to quantum dots. Different types of nanoparticles: metal nanoparticles and monolayer substituted nanoparticles- fullerenes

**Unit II:**


**Unit III:**

**Characterisation of nanomaterials** : Important methods for the characterisation of nanomaterials – electron microscopy (SEM), transmission electron microscopy (TEM), scanning tunneling electron microscopy (STEM), environmental transmission electron microscopy (ETEM), scanning probe electron microscopy (SPL), secondary ion mass spectrometry (SIMS)-photoelectron spectroscopy (UPES and XPES).

**Unit IV:**

**Electrical and optical properties of nanomaterials**

Electrical and optical properties of nanoparticles- electrical and optical properties of carbon nanotubes- nanocatalysis nanolithography- nanochemical devices- optoelectronic devices- photodetectors- LEDs and lasers.

**Unit V:**

**Applications of nanomaterials** : Nanocrystals- immunology labelling- applications in medical diagnosis- nanobased drug delivery- applications in biotechnology- nanosensor based on quantum size effects- nano biosensors nano medicines- destructive applications of nanomaterials- nanomaterials in war.

**Text books:**


**References:**

2. V. S. Muraleedharan and A. Subramania, Nanoscience and nanotechnology, Ane Books Pvt. Ltd. New Delhi, 2009
4. R. Booker and , E. Boysen, Nanotechnology, Wiley India Pvt Ltd, 2008
Objectives:
To understand the common diseases and the cure
To know the terms of pharmacology
To understand the mechanism of drug action
To acquire knowledge about chemotherapy and the antibiotics
To understand the drugs used for diabetes, hypertension, cholesterolemia
To acquire knowledge about various health promoting drugs

Unit I:

Unit II:

Unit III:
Common body ailments: Diabetes - Causes, hyper and hypoglycemic drugs -Psychedelic drugs, hypnotics, sedatives (barbiturates, LSD) - Blood pressure - Systolic & Diastolic Hypertensive drugs - Cardiovascular drugs – anti arrhythmic, antianginals, vasodilators – CNS depressants and stimulants – Lipid profile - HDL, LDL cholesterol, lipid lowering drugs.

Unit IV:
Health promoting medicines: Nutraceuticals-Vitamins A B C D E and K (structure) micronutrients such as Na, K, Ca, Cu, Zn, I -Medicinally important inorganic compounds of Al, P, As, Hg, Fe

Unit V:
Organic Pharmaceutical acids and bases: Organic Pharmaceutical acids; Agents for kidney function (Aminohippuric acid); Agents for liver function (Sulfobromophthalein); Agents for pituitary function
(metyrapone) - Organic pharmaceutical bases - antioxidants, treatment of ulcer and skin diseases.

Text books:

References:

18CHY356 SUPRAMOLECULAR CHEMISTRY

Objectives: To understand the molecular to supramolecular chemistry

Unit I:
Introduction to Supramolecular Chemistry: From molecular to supramolecular chemistry: Factors leading to strong binding, hydrogen bonding and stacking interactions, Bottom-up approach, Top-Down Approach, Energy and Signals, photo switching devices, electro switching devices, mechanical switching processes,

Unit II:
Processing of Energy and Signals by Molecular and Supramolecular system: Fundamental principles of photo induced electron and energy transfer, Molecular electronics, Molecular photonics, Molecular Chemionics, Molecular electro photonics, Molecular Photochemionics.

Unit III:

Unit IV:
Electrochemistry of Supramolecular Systems: Electroluminescent systems as sensors and devices, Redox controlled molecular switches, Biohybrid electrochemical devices, Dendrimers as multielectron
Unit V:

**Molecular Scale Mechanical Devices:** Introduction to mechanical devices, Spontaneous mechanical like motions, Allosteric movements, Tweezers and Harpoons, A natural proton pump, Twisters, Molecular valves, Molecular Muscles.

**Text books:**

**References:**

18CHY381 CHEMISTRY PAPER-VI PRACTICALS 0-12

1. To study the effect of dilution on Molar Conductivity of weak and strong electrolytes.
2. Conductometric titrations
3. Potentiometric is titrations.
4. Acid Hydrolysis of Ester
5. Base Hydrolysis of an Ester by Titration and Conductometry
7. Gravimetric estimation of Barium as barium sulphate.

18CHY382 PRACTICALS 0-12
1. **Organic preparations:**
Recrystallisation and determination of melting point and its importance may be mentioned
(a) Acetylation: Preparation of acetanilide from aniline
(b) Oxidation: Preparation of benzoin acid from benzaldehyde
(c) Nitration: Preparation of m-dinitrobenzene from benzene
(d) Hydrolysis: preparation of benzoic acid from ethyl benzoate

2. **Quantitative organic analysis** (Any four)
(a) Estimation of aniline by bromate-bromide method
(b) Estimation of glucose by Fehlings method
(c) Determination of iodine value of an oil by Vij’s method
(d) Determination of saponification value of an ester / oil
(e) Estimation of amino acid by formal titration method
(f) Estimation of ascorbic acid in Vitamin C tablets by Volumetry
(g) Estimation of Paracetamol by titrimetric and photo spectrometric methods.
(h) Gravimetric Analysis of Lead, Iron and Nickel

3. **Chromatographic Techniques** (Any two)
(i) Thin Layer Chromatography
   Determination of Rf values and identification of organic compounds:
   (a) Separation of green leaf pigments (spinach leaves may be used)
   (b) Separation of mixture of dyes
(ii) Paper Chromatography
   Determination of Rf values and identification of organic compounds:
   (iii) Column Chromatography: Separation of ortho and para nitroanilines

18CSA203                                         PC Software

**Unit -3**
Film review,Audio –Visual-Media in Hindi – Movies appreciation and evaluation.News reading and presentations in Radio and Tv channels in Hindi, samvaadhlekhan,

**Unit -4**
a) Harishankarparsaiyi- SadacharkaThavis
b) Jayashankarprasadh – Mamata
c) Mannubandari- Akeli
d) Habibtanvir- Karthus
Objective: The preliminary objective is to ensure that every student has some knowledge about Indian Constitution.

Unit 1
Meaning and Importance of Constitution, Preamble and Salient Features of the Constitution.

Unit 2
Fundamental Rights, Right to Equality, Right to Freedom, Right against exploitation, Right to freedom of religion, Cultural and Educational Rights, Right to Constitutional Remedies and Duties, Directive Principles of State Policy.

Unit 3
Union Government – Lok Sabha and Rajya Sabha Composition, Powers and functions: The President, The Prime Minister and Supreme Court: Role Position and Powers/ functions.

Unit 4
State Government - Legislative Assembly and Legislative Council: Composition, Powers and functions: The Governor, Chief Minister and High Court: Role, Position and Powers/ functions.

Unit 5
Local self Government, Panchayat Raj System in India; Election Commission; Public Service Commissions, Role, powers and function

Skill development Activities:
• Court Visit & Report Presentation
• Group discussion(Fundamental rights and duties)

REFERENCES:
1. Introduction to The constitution of India – M V Pylee, Vikas publishing house Pvt LTD
2. Introduction to The constitution of India – Dr. Durga das Basu, 19th edition Reprint 2007

18MAT101 CALCU LCS 3-1-0 4

Objective: To enable students to understand the meaning of differentiation and integration and apply the techniques of indefinite and definite integration

Unit I:
Chapter-2 (Sections 2.3-2.7)

Unit II:
**Differentiation:** The Derivative as a Function – Differentiation Rules – The Derivative as a Rate of Change – Derivatives of Trigonometric Functions – The Chain Rule and Parametric Equations – Implicit Differentiation -\(n\)th derivatives of the functions: \(e^{ax}\), \((ax + b)^n\), \(\log(ax + b)\), \(\sin(ax + b)\), \(\cos(ax + b)\), \(e^{ax}\sin(bx + c)\), \(e^{ax}\cos(bx + c)\) – Problems.

Chapter-3 (Sections 3.1-3.6)

**Unit III:**

**Application of Derivatives:** Extreme values of Functions – The Mean Value Theorem – Monotonic Functions and the First Derivative Test – Concavity and Curve Sketching.

Chapter-4 (Sections 4.1-4.4)

**Unit IV:**


Chapter-5 (Sections 5.1-5.6)

**Unit V:**

**Techniques of Integration:** Basic Integration Formulas – Integration by Parts – Integration of Rational Functions by Partial Fractions – Trigonometric Integrals – Trigonometric Substitutions – Improper Integrals.

Chapter-8 (Sections 8.1-8.4, 8.8)

**Text books:**

**References:**

S Balachandra Rao, Differential Calculus, New Age Publications, 2005

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**18MAT118 MATRICES AND VECTOR CALCULUS 3-1-0 4**

**Objectives:** To enable students to understand the basic concepts of matrix calculus, vectors and basic vector operations and solve computational problems of vector calculus

**Unit I:**

**Systems of Linear Equations:** Linear System of Equations, Gauss Elimination, Consistency of a linear system of equations, Vectors, Linear independence and dependence of vectors, Rank of a Matrix.

Text Book-1: Chapter-1 and 2

**Unit II:**
**Eigen value problems:** Eigen values, Eigen vectors, Properties of Eigen values and Eigen vectors, Cayley-Hamilton theorem, Some Applications of Eigen value Problems, Similarity of Matrices, Diagonalization of a matrix, Power of a matrix, Diagonalization by orthogonal transformation, Quadratic forms, Canonical form of a quadratic form, Nature of quadratic forms.

Text Book-1: Chapter-7.

**Unit III:**
Three dimensional coordinate systems, vectors, dot and cross products. Vector Differentiation: Gradient, divergence and curl, identities, invariant scalar.

Text Book-2: Chapter-12 (Sections 12.1-12.5)

**Unit IV:**
Line integrals, Vector Fields, Work, Circulation an ,and Flux, Path Independence, Potential Functions, and Conservative Fields, Green’s Theorem in the plane.

Text Book-2: Chapter-16 (Sections 16.1-16.4)

**Unit V:**
Surface area and surface integrals, Parameterized surfaces, Stokes Theorem, The divergence Theorem and a unified theory

Text Book-2: Chapter-16 (Sections 16.5-16.8)

**Text books:**


**References:**

**Objectives:** To enable students to develop the knowledge of standard concepts of ordinary differential equations and apply analytical techniques to compute solutions to various differential equations

**Ordinary Differential Equations**

**Unit I:**

Review of differential equations (order, degree, linear, nonlinear, implicit and explicit form of solution, general solutions, particular solution, singular solution). Exactness, nonexact equations reduce to exact form.
Part I: 1.1-1.9, 2.12-2.22

**Equations of first order but of higher degree:** Equations solvable for \( \frac{dy}{dx}, y, x \), equations in Clairaut’s form equations reducible to Clairaut’s form.
Part I: 4.1-4.11

**Unit II:**

**Equations of Second order:** Linear homogeneous differential equations with constant coefficients, Euler- Cauchy equation, Linear Nonhomogeneous Differential Equations: Wronskian, linear independence, Method of undetermined coefficients. Method of variation of parameters.
Part I: 5.1-5.5, 6.1-6.3, 1.12, 1.13, 5.26-5.27, 7.1-7.5

**Unit III**

**Systems of first order linear equations:** Conversion of nth order differential equation to n first order differential equations, homogeneous linear system with constant coefficients, fundamental matrices, complex eigen values, repeated eigenvalues. simultaneous linear differential equations with constant coefficients, simultaneous linear differential equations with variable coefficients,

**Partial Differential Equations**
Review of partial differential equations (order, degree, linear, nonlinear).

**Unit IV**

Formation of equations by eliminating arbitrary constants and arbitrary functions.

**Solutions of partial differential equations:** General, particular and complete integrals. Lagrange’s linear equation, Charpit’s method, Methods to solve the first order partial differential equations of the forms \( f(p,q) = 0 \), \( f(z,p,q) = 0 \), \( f_1(x,p) = f_2(y,q) \) and Clairut’s form \( z = px + qy + f(p,q) \) where \( p = \frac{\partial z}{\partial x} \) and \( q = \frac{\partial z}{\partial y} \).
Part III: 1.1 – 1.5, 2.3-2.12, 3.1-3.2, 3.7-3.8, 3.10-3.18

**Unit V**

Part III:  8.1, 4.1-4.12

Text books:

References:

18MAT222                             MODERN ALGEBRA                      3-1-0   4

Objectives: To enable students to understand fundamental concepts of algebra and apply results from elementary group theory to solve contemporary problems.

Unit I:

Unit II:

Unit III:
Automorphisms, Cosets and Lagrange"s Theorem, Application of Cosets to Permutation Groups. Normal Subgroups, Factor Groups, Applications of Factor Groups. Group

**Unit IV:**
Chapters 23-24.

**Unit V:**
Quotient Rings and Ideals. Homomorphism of rings and rings of polynomials.
Chapters 28-30.

**Textbooks:**

**References:**

**18MAT301 REAL ANALYSIS 2-1-0 3**

**Objectives:** To enable students to understand the basic properties of the field of real numbers and understand notion of continuous functions and their properties.

**Unit I:**
**Review:** Sets and Functions, Mathematical Induction, Finite and Infinite Sets. The Real Numbers-The Algebraic and Order Properties of R, Absolute Value and the Real Line, the Completeness Property of R, Applications of the Supermom Property. Chapter-2 (Sec.2.1-2.3)

**Unit II:**
Chapter-3 (Sec.3.1-2.6)

**Review of Limits**-Limits of Functions, Limit Theorems. (Chapter-4, review only)

**Unit III:**
**Continuous Functions**-Continuous Functions, Combinations of Continuous Functions, Continuous Functions on Intervals, Uniform Continuity.
Unit IV:
**Differentiation** - The Derivative, The Mean Value Theorem, L'Hospital's Rules, Taylor's Theorem.
Chapter-6 (Sec.6.1-6.4)

Unit V:
Chapter-7 (Sec.7.1-7.4)

Textbooks:

References:

18MAT309 DISCRETE MATHEMATICS 1-1-0 2

Objectives: To enable students to understand the basics of logic, permutations and combinations and use effectively algebraic techniques to analyse basic discrete structures and algorithms

Unit I
**Logic** - Logic, Prepositional Equivalence, Predicate and Quantifiers, Theorem Proving.
Chapter-1 (Sections: 11.-1.5)

Unit II
Basics of Counting, Pigeonhole Principle, Permutation and Combinations.
Chapter-4 (Sections: 4.1-4.3)

Unit III
**Advanced Counting Techniques and Relations** - Recurrence Relations, Solving Recurrence Relations, Solutions of Homogeneous Recurrence Relations.
Chapter-6 (Sections: 6.1-6.2)

Unit IV
**Relations and Their Properties** - Representing Relations, Closure of Relations, Partial Ordering, Equivalence Relations and partitions.
Chapter-7 (Sections: 7.1, 7.3-7.6)

Unit V

Graph Theory: Introduction to Graphs, Graph Operations, Graph and Matrices, Graph Isomorphism, Connectivity, Euler and Hamilton Paths, Shortest Path Problems.

Chapter-8 (Sections: 8.1, 8.4-8.6)

Text books:

References:

18MAT320 PROBABILITY AND STATISTICS       1- 1- 0   2

Objectives: To enable students to understand the properties of probability and probability distributions and apply wide variety of specific statistical methods

Unit I:

Probability Concepts: Important definitions- random experiment, trial, sample space, mutually exclusive events, independent events, dependent events, equally likely events, exhausitve events – approaches to measuring probability.

Unit II:


Unit III:


Unit IV:

Correlation: Introduction to simple correlation - scatter plot and correlation coefficient, properties of correlation coefficient, rank correlation coefficient.

Unit V:
Regressions: Introduction to simple regression, regression lines.

Text books:


References:


Text book:


References:


18MAT321 COMPLEX ANALYSIS 2-1-0 3

Objectives: To enable students to obtain knowledge of theory of complex functions of a complex variable and get acquainted with different methods and techniques of series and bilinear transformations.

Unit I
Definition, Algebra of complex numbers, polar forms, regions, Limits, continuity, differentiability Analyticity, CR equations, Harmonic Functions. Chapters 1 & 2

Unit II
Conformal mappings, bilinear transformations, Special bilinear transformations, fixed points. Chapter-9 (Sections: 9.1-9.3)

Unit III
Contour integral, Cauchy-Goursat theorem, Cauchy’s integral formula, winding number, Primitives
Chapter-4 (Sections: 4.1-4.4, 4.7)

Unit IV
Sequences, series, power series, uniform convergence of power series, Taylor’s series, Laurent’s series, Integration and differentiation of Power series.
Chapters- 5 & 6 (Sections: 5.1-5.2, 6.1, 6.3-6.5)

Unit V
Zeros and singularities of analytic functions, types of singularities, poles, residue theorem.
Chapter-7 (Sections: 7.1-7.3)

Text books:

References:

18MAT341 OPERATIONS RESEARCH 3 0 0 3

Objectives:
To enable students to
• Understand the concept of linear programming and its problems
• Apply the knowledge of networks

Unit – I


Unit – II

Transportation Models: Introduction to transportation - mathematical formulation of transportation problem, methods for initial basic feasible solution methods, MODI method for optimal.
Unit – III
**Assignment Models:** Introduction to assignment problem, mathematical formulation of assignment problem.

Unit – IV
**Queuing Theory:** Introduction to queuing theory, characteristics of queuing theory, single channel queuing models with finite and infinite size, solution to single channel queuing models.

Unit – V
**CPM and PERT:** Network logic, concepts and definition, network scheduling by critical path method, program evaluation and review technique.

**Text books and References:**


**18MAT342** **NUMERICAL METHODS** **3 0 0 3**

**Objectives:** To enable students to

- Understand the concept of interpolation and approximation
- Apply various techniques of solving transcendental and polynomial equations

**Unit I:**
Roots of Transcendental and Polynomial Equations: Bisection method, Iteration methods based on first degree equation, Rate of convergence, system of nonlinear equations. Solution of System of Linear Algebraic Equations: Iteration methods Eigenvalues and Eigenvectors: Jacobi Method for symmetric matrices, Power method for arbitrary matrices. Sections: 2.2, 2.3, 2.5, 2.7, 3.4, 3.5, 3.6

**Unit II:**
Interpolation and Approximation: Lagrange and Newton interpolation for unequal intervals, Finite difference operators, Interpolating polynomials using finite differences. Sections: 4.2, 4.3, 4.4.

**Unit III:**
Differentiation and Integration: Numerical differentiation, Methods based on interpolation, Numerical integration, Methods based on undetermined coefficients. Sections: 5.2, 5.6, 5.7, 5.8

**Unit IV:**

**Unit V:**
Sections: 12.1, 12.2, 12.3

Text books:

References:

18MAT343 INTEGRAL TRANSFORMS AND FOURIER SERIES 3 0 0 3

Objectives: To enable students to
• Acquaint with the knowledge of fourier analysis and Laplace transforms
• Solve the linear ordinary differential equations

Unit – I
Fourier Analysis: Fourier series, Complex Form of Fourier Series, Parseval’s Identity,
Unit – II
Fourier Integrals, Fourier integral theorem.
Unit-III
Infinite Complex Fourier Transforms, Sine and Cosine Transforms, Properties, Convolution theorem and Parseval’s theorem.
Unit – IV
Laplace Transforms: Laplace Transforms, Inverse Transforms, Properties, Transforms of Derivatives and Integrals, Second Shifting Theorem, Unit Step Function and Dirac-Delta Function, Differentiation and Integration of Transforms.

Unit – V
Convolution, Initial and Final Value Theorems, Periodic Functions, Solving Linear Ordinary Differential Equations with Constant Coefficients, System of Differential Equations and Integral Equations.

Text books:

References:
Objectives: To enable students to
- Understand the concept of statistical inference of two samples
- Apply statistical techniques in quality control

Unit – I

Sections: 9.1-9.9

Unit – II

Statistical Inference for Two Samples: Inference on the Difference in Means of Two Normal Distributions, Variance Known and Unknown, A nonparametric tests for difference in Two means, Paired t test, Inference on the variances of the Two Normal Distributions.
Sections: 10.1-10.6

Unit – III

Sections: 13.1-13.4

Unit – IV

Design of Experiment with several factors: Introduction – Latin Square Design – statistical model for LSD, computation of sum of squares – two factor factorial experiment – main and interaction effects, data and statistical model- computation of sum of squares.
Sections: 14.1-14.5
Unit –V

Statistical Quality Control: Quality improvement and statistics, Introduction to control limits - control charts for variables – X-bar chart, R-chart, S chart for individual observations - attribute control charts – Control charts for Proportions and for defects per unit. Sections : 15.1-15.6

Text books:


References:


18MAT345 NUMBER THEORY 3 0 0 3

Objectives: To enable students to

• Understand the concept of divisibility, congruencies and arithmetical functions
• Understand the concept of primitive roots and Diophantine equations

Unit I:

Divisibility: Definition, properties, division algorithm, greatest integer function (Sec 1.1)
Primes: Definition, Euclid's Theorem, Prime Number Theorem (statement only), Goldbach and Twin Primes conjectures, Fermat primes, Mersenne primes. The greatest common divisor: Definition, properties, Euclid's algorithm, linear combinations and the GCD - The least common multiple: Definition and properties. The Fundamental Theorem of Arithmetic: Euclid's Lemma, canonical prime factorization, divisibility, gcd, and lcm in terms of prime factorizations. Primes in arithmetic progressions: Dirichlet's Theorem on primes in arithmetic progressions (statement only) (Sec 1.2 to 1.5)

Unit II:
Congruences: Definitions and basic properties, residue classes, complete residue systems, reduced residue systems - Linear congruences in one variable, Euclid's algorithm - Simultaneous linear congruences, Chinese Remainder Theorem - Wilson's Theorem - Fermat's Theorem, pseudoprimes and Carmichael numbers - Euler's Theorem (Sec 2.1 to 2.6).

**Unit III:**

Arithmetic functions: Arithmetic function, multiplicative functions: definitions and basic examples - The Moebius function, Moebius inversion formula - The Euler phi function, Carmichael conjecture - The number-of-divisors and sum-of-divisors functions - Perfect numbers, characterization of even perfect numbers (Sec 3.1 to 3.6).

**Unit IV:**

Quadratic residues: Quadratic residues and nonresidues - The Legendre symbol: Definition and basic properties, Euler's Criterion, Gauss' Lemma - The law of quadratic reciprocity (Sec 4.1 to 4.3).

**Unit V:**

Primitive roots:
The order of an integer - Primitive roots: Definition and properties - The Primitive Root Theorem: Characterization of integers for which a primitive root exists (Sec 5.1 to 5.3).

**Diophantine Equations**

Linear Diophantine Equations - Pythagorean triples – Representation of an integer as a Sum of squares (Sec 6.1, 6.3, 6.5).

**Text book:**

**References:**

Objectives: To enable students to
• Understand gamma and beta functions
• Solve the Legendre equations using various techniques

Unit I
Gamma and Beta Functions and Elliptic Functions
Part II: 4.1 – 4.11

Unit II
Special functions, power series solution of differential equations, ordinary point; Solution about singular points, Frobenius method. Bessel’s equation, solution of Bessel’s equation, Bessel’s functions J_n(x).
Part II: 8.5-8.6, 8.8- 8.10, 11.1, 11.2.

Unit III
Recurrence Formulae, Equations reducible to Bessel’s equation, orthogonality of Bessel’s Functions, A generating function for J_n(x).
Part II: 11.8, 11.10, 11.11.

Unit IV
Legendre’s equation, Legendre’s polynomial P_n(x), Legendre’s function of the second kind [Q_n(x)], General solution of Legendre’s equation, Rodrigue’s formula, Legendre polynomials, A generating function of Legendre’s polynomial.
Part II: 9.1-9.4.

Unit V
Orthogonality of Legendre polynomials, Recurrence formulae for P_n(x) Green’s function – Green’s Identities – Generalized functions

Text books:
• M.D. Raisinghania, Ordinary and Partial Differential Equations, S.Chand, 18th edition, 2016

References:
• I. N. Sneddon - Special Functions of mathematical Physics & Chemistry, 3 Oliver & Boyd, London.
• N. N. Lebedev - Special Functions and Their Applications, PHI.
• Special Functions, R. Askey and R. Roy, Cambridge.

18PHY103 MECHANICS 3- 0- 2 4
Objectives: To enable students to understand Newtonian mechanics and apply Newton’s laws to explain natural physical phenomena.

Unit I:
Vector Analysis: Integrals (line, surface and volume), Physical significance of Gradient, Divergence and curl, statement of Gauss’s and Stroke’s theorems.

Particle dynamics: Review of the equations of motion, projectile motion, Newton’s First, Second and Third Law of Motion, Newton’s I Law as a basic kinematical law defining a frame of reference, Newton’s II Law as a basic dynamical law of mechanics and Newton’s III law as an interaction law, Frames of reference, inertial and non-inertial, pseudo forces, Force laws, weight and mass, Application of Newton’s law, importance of free body diagrams representing forces on the body in a free body diagram and frictional forces. Discussion of importance of friction in daily life.

Unit II:
Work and Energy: Work done by a constant force and by a variable force – one and two dimensional cases. Kinetic energy and work-energy theorem, Significance of the work-energy theorem, power. The importance of language in Physics to be highlighted by differentiating the meaning of ‘work’, ‘power’, ‘energy’ as defined in Physics and in daily life.

Conservation Laws: Introduction, conservative forces, potential energy, complete solution for one, two and three dimensional systems, non-conservative forces, conservation of energy, conservation of energy to be seen as a spreading out and appearing in different forms, mass and energy.

Conservation of Linear Momentum: Centre of mass, motion of the center of mass, linear momentum of a particle, linear momentum of a system of particles, conservation of linear momentum, some applications of momentum principle, systems of variable mass – Rocket equation.

Collisions: Elastic and Inelastic, Collision in one and two dimensions.

Unit III:
Gravitation: Historical Introduction, Newton’s law of Universal Gravitation, Universal Gravitation constant ‘G’, inertial and gravitational mass, variation in acceleration due to gravity with altitude and depth, motion of planets and satellites, gravitational field and potential, gravitational potential energy, potential energy for many particle systems, calculations of field and potential for (a) a spherical shell, (b) a sphere, energy consideration in the motion of planets and satellites.

Central Force: Kepler’s laws of planetary motion, the inverse square law, Rutherford’s problem, derivation of Kepler’s Law from Universal law of Gravitation.
Rotational Kinematics
Rotational variables, angular velocity, angular acceleration. Rotation with constant angular acceleration, Linear and angular variables, kinetic energy of rotation, rotational inertia, calculation of rotational inertia – of a rod, sphere and cylinder, torque, Newton’s laws of rotation, work, power and work – kinetic energy theorem.

Unit V:

Dynamics of Rigid bodies
Angular momentum and moment of inertia, Theorem on moment of inertia, moment of inertia for (i) solid cylinder, (ii) rectangular slab, (iii) solid sphere and (iv) circular hoop.

Fluid Mechanism
Ideal fluids, Equation of Continuity, Viscous fluids, critical velocity, Derivation of Poiseuille’s Equation.

PRACTICALS
(A minimum of ten experiments to be done from the list given below)
1. To Determine the Momentum of Inertia and Mass of a Flywheel.
2. Study of the motion of an air bubble.
3. Study of the motion of a freely falling body
4. Study of the acceleration of a body subjected to different unbalanced forces
5. Study of accelerations of different masses under a constant unbalanced force.
6. Study of conservation of energy and momentum in head-on-collision between two spheres of equal mass.
7. Conservation of momentum in an explosion
8. Determination of Surface tension of liquid by capillary rise method.
9. To study the relation between length and time period of a simple pendulum
10. Study of the rate of flow of water through a capillary tube under different pressure heads
11. Momentum of inertia of a rod by torsional oscillation.
12. Determination of Acceleration due to Gravity and radius of gyration by Bar Pendulum

Text books:

References:


18PHY112 WAVES, HEAT AND THERMODYNAMICS 3-0-2 4

Objectives: To enable students to see relation between linear and rotational motion and understand the production and propagations of waves in elastic media. And also understand the laws of thermodynamics and its applications.

Unit I:

Oscillations: Simple Harmonic Motion (SHM), the restoring force along with its kinematical model, force law, SHM equation and idea of phase and phase difference, energy considerations in simple harmonic motion. Superposition of the SHMs, Lissajous figures, Equation for damped vibrations, forced vibrations. Analysis of complex waves. Fourier series, Application to square wave, triangular wave.

Waves in elastic media: Review of Mechanical waves, types of waves, travelling waves, the superposition principle, wave speed, power and intensity in wave motion, expression for transverse waves in a stretched string, interference of waves, standing waves, resonance, simulation and demonstrations using ripple tank.

Sound Waves: Audible, ultrasonic and infrasonic waves, propagation and speed of longitudinal waves, travelling longitudinal waves, standing longitudinal waves, vibrating systems and source of sound, beats and Doppler effect, wave equation for sound pressure, sound power and its measuring unit (decibel).

Unit II:

Unit III:

**Heat and First Law of Thermodynamics:** Thermal equilibrium, Zeroth law of thermodynamics, ideal gas temperature scale, heat as a form of energy, quantity of heat and specific heat, molar heat capacities of solids, the mechanical equivalent of heat, heat and work; First law of thermodynamics, Discussion on usefulness of First Law of Thermodynamics in Meteorology, some special cases of the first law of thermodynamics – (i) adiabatic process, (ii) isothermal process, (iii) isochoric process, (iv) cyclic process, (v) free expansion.

Unit IV:

**Entropy and Second Law of Thermodynamics:** Introduction, reversible and irreversible processes, the Carnot cycle, Carnot engine, Carnot theorem, absolute scale of temperature, second law of thermodynamics, efficiency of engines, the thermodynamic temperature scale, entropy in reversible and irreversible processes, entropy and the II law, entropy and disorder, consequences of II and III law of thermodynamics, Second law of thermodynamics as a probabilistic statement. Low temperature Physics – Porous Plug experiment, temperature of inversion, principle of regenerative cooling, liquefaction of air by Linde’s method.

Unit V:

**Thermodynamic potentials:** Internal Energy, Enthalpy, Helmholtz function, Gibbs function, relations among these functions, Gibbs-Helmholtz equations

**Maxwell's Thermodynamic Relations:** Derivation of Maxwell's thermodynamic relations, TdS equations, Internal energy equations, Heat capacity equations. Change of temperature during adiabatic process using Maxwell's relations

**PRACTICALS**

(A minimum of ten experiments to be done from the list given below)

1. Study of the oscillations of a column of water as a function of its length and study of damped oscillation
2. To determine the velocity of sound at $0^\circ C$ and the end correction by setting up a resonance column (first resonance length)
3. Study of torsional oscillations of a loaded wire and determination of the rigidity modulus of the material of the wire
4. Verification of Stefan’s Boltzmann law using Potentiometer
5. Study of Newton’s law of cooling.
6. Determination of Thermal conductivity of a bad conductor by Lee Charlton method
7. Specific heat of a solid by the method of mixtures
8. Determination of latent heat of fusion of ice by calorimetric method
9. J by Joules Calorimeter
10. Study of transverse vibrations on a sonometer. To determine the frequency by (i) absolute method, (ii) Comparison method
11. Melde’s experiment – determination of frequency
12. Frequency of AC by a sonometer.

Text books:


References:


18PHY202 ELECTRICITY AND MAGNETISM 3-0-2 4

Objective: To enable students to acquire a broad conceptual framework of electromagnetic phenomena.

Unit I:

Electrostatics: Electrical pressure on a charged surface. The path traced by a charged particle in a transverse electric field. The attracted disc electrometer – construction, theory and applications.
Review of concept of electric field and electric field due to point charge. Electric field due to (i) electric dipole, (ii) line of charge and (iii) charged disc
A dipole in an electric field, torque on a dipole in uniform and non-uniform E fields, potential energy of an electrical dipole.

Unit II:

Electric Fields in matter: Capacitance, parallel plate capacitor, calculation of capacity of a spherical and cylindrical capacitor, energy stored in a capacitor, capacitor with dielectric,
atomic view of dielectrics, polarization, electric field due to a polarised material, Gauss’s law in dielectrics, Dielectric constant, Energy density of an electrostatic field (with and without dielectric).
Polarisability and susceptibility – Frequency dependence of polarisability, Clausius- Mossotti equation.

**Unit III:**

**Magneto statics:** Review of Ampere’s law, B near a long wire, Magnetic lines of induction, force between two parallel conductors, definition of ampere, B for a solenoid, Biot-savart’s law, and applications of Biot-savart’s law.
The magnetic field, Lorentz force and definition of magnetic field, magnetic induction, magnetic force on a current element, circulating charges, Cyclotron resonance frequency, Cyclotron. Magnetisation, magnetization current density, magnetic field intensity, magnetic susceptibility and permeability.

**Unit IV:**

**Electromagnetic Induction:** Review of Faraday’s law, Faraday’s experiment, Lenz’s law, Time varying magnetic fields, Application in betatron.
**Inductance:** Self-inductance, LR circuit, energy in a magnetic field, magnetic energy density.

**Unit V:**

**Alternating current and filter:** R M S values, Response of LR, CR and LCR circuits to sinusoidal voltages (discussion using the j symbol), Series and parallel resonance, Half-power frequencies, bandwidth and Q-factor, Power in electrical circuits, power factor, Maximum power transfer theorem (with proof).
High-pass and low-pass filters with LR and CR combinations, Cut-off frequency, Band-pass filters.

**PRACTICALS**
*(A minimum of ten experiments to be done from the list given below)*

1. Determination of Q factor by series resonance
2. Determination of Q factor by parallel resonance
3. Determination of self-inductance of a coil using Anderson’s Bridge
4. Determination of capacitance by measuring impedance of RC circuit
5. Determination of Inductance by measuring impedance of RL circuit
6. Mutual inductance of a solenoid by Ballistic Galvanometer
7. De Sauty’s Bridge
8. Determination of resistivity of a material using low resistance
9. Determination of the specific charge of a copper(Cu++) ion using Copper Voltammeter
10. Study of decay of current in LR and RC circuit
11. Measurement of B by current balance
12. To show that the behavior of an inductance in an AC circuit is analogous to that of a resistor which obeys Ohm’s Law and hence to measure inductance.

Text books:

1. Electricity and Magnetism, Fewkes and Yarwood.
2. Electricity and Magnetism: A N Matveev, Mir Publishers, Moscow.
3. Electricity and Magnetism, F.W.Sears, Addison Wesley Co.

References:

   Ltd.
   Ltd., New Delhi

18PHY215 OPTICS 3 -0 -2 4

Objectives: To enable students to understand that light is a wave phenomenon and apply the understanding of wave phenomenon to light.

Unit I:

Young’s experiment - coherence, intensity distribution and visibility of fringes, Newton’s rings, Fresnel’s Biprism, interference in thin films, colours of thin films, interference at an air wedge, Michelson’s interferometer.

Unit II:

**Diffraction:** Fraunhoffer and Fresnel: Diffraction, Diffraction at a single slit, double slit, Diffraction by multiple slits, Diffraction grating, Resolving power – Rayleigh’s criterion, Resolving power of a grating and telescope. 
Fresnel diffraction, half period zone, zone plate, diffraction at a circular aperture and at a straight edge (qualitative treatment only).

Unit III:

**Polarization:** Polarization by reflection, Brewster’s law, Mauls law, Double refraction, Production and detection of linearly, circularly and elliptically polarized light, Quarter and half wave plates, Polaroid’s, Discussion on use of Polaroid sheets in preparing tinted sunglasses, Optical activity.

Unit IV:

**Scattering of Light:** A brief discussion on Tyndall effect, Rayleigh scattering and Raman effect. Blue of the sky and ocean. A qualitative account of fluorescence and phosphorescence. Raman effect: Classical and quantum theory of Raman effect, experimental method for studying Raman spectra, Raman spectrum, study of Raman effect using Lasers, intensity of Raman lines, Polarization of Raman lines, characteristic properties of Raman lines, applications of Raman effect.

Unit V:

**Introduction to Lasers:** Spontaneous and stimulated emission, density of states, Einstein’s A and B coefficients. Ratio of stimulated to spontaneous transitions in a system in thermal equilibrium, condition for amplification, population inversion, methods of optical pumping, energy level schemes of He-Ne and Ruby Laser. Properties and uses of Lasers. 
Basic concepts of holography – construction of hologram – Discussion on the use of holograms in daily life - Recording and reproduction of holograms.

**PRACTICALS**

1. Determination of wavelength of mercury spectral lines using Diffraction Grating by normal incidence method
2. Determination of the refractive index of the material of a prism by minimum deviation method
3. Determination of Cauchy’s constants using a prism, grating and spectrometer
4. Determination of the resolving power of a telescope
5. Determination of wave length of monochromatic light source using Bi-Prism
6. Resolving power of a grating
7. Wavelength and wavelength difference using a Michelson’s interferometer
8. Determination of the thickness of paper by interference at a wedge
9. Determination of the radius of curvature of the lens by Newton’s Rings
10. Determination of the refractive index of a liquid by Newton’s rings
11. Verification of Brewster’s Law
12. Refractive index of a prism by i-d curve

Text books:


References:

3. Khanna and Bedi: Sound
Objectives: To enable students to understand the physics of semiconductors and their applications in basic electronic circuits.

Unit I:

Semiconductor Characteristics and Applications Review: Intrinsic and extrinsic semiconductors, electrons and holes in intrinsic and extrinsic semiconductors, conduction by electrons and holes, conductivity of a semiconductor, Energy bands in semiconductors. Carrier concentrations in intrinsic and extrinsic semiconductors, Fermi level, donor and acceptor levels in extrinsic semiconductors.
P-N junction diode – depletion layer, conduction in PN junction diode, characteristics, diode resistance.
Half wave and full wave rectifiers, power output and efficiency, Ripple factors.
Breakdown in diodes – Zener breakdown, Zener diode characteristics and application in voltage regulation.
LEDs, photo diodes, LDRs and Solar cells.

Unit II:

Transistors and Applications: Bipolar junction transistor (PNP and NPN) transistors, different configurations and characteristics, current components in CE configuration, large signal and small signal dc current gains, transistor biasing – self bias circuit, Load line and operating point.
Transistor as an amplifier: Transistor as a two port device, h-parameters and analysis of CE amplifier using h parameter equivalent circuit, simplified h-parameter circuit, stabilization of voltage gain in CE amplifiers, Two stage amplifiers, RC coupling, frequency response of CE amplifier. Comparison of transistor configurations.
Emitter follower circuit and its use. Transistor as Power amplifier.
FET construction and its characteristics – MOSFET characteristics.
Concept of feedback in amplifiers and advantages of negative feedback.

Unit III:


Unit IV:

Digital Electronics: Binary to decimal and decimal to binary conversion, Binary addition and subtraction, Octal number system, Hexadecimal system and conversions.
Construction and working of AND and OR logic gates using diodes. Construction of NOT gate using transistor. Symbols and truth table for AND, OR, NOT, NAND NOR and Ex-OR.
logic gates. Boolean algebra, Boolean laws, D’morgan’s theorem. NAND and NOR as
universal gates.
Introduction to OP-AMP. Differential amplifiers, principle of OP-AMP, OP-AMP
parameters, Applications – Addition, Subtraction, differentiation and integration.

**Unit V:**

**Communication Electronics:** Basic theory of amplitude modulation, Power in modulated
carrier, single side band transmission, Basic idea of frequency and phase modulation.
Modulated class C amplifier, demodulation, and PN diode as demodulator linear and square
law detection.
Propagation of radio waves, different layers of ionosphere and their functions,
Radio communication: Role of ionosphere in radio communication. Block diagram of Radio
transmission. The block diagram and diagram of super heterodyne AM Receiver.

**Text books:**

1. V.K. Mehta: Electronics.
3. Ramakant Gaekwad: Operational amplifiers and Linear Integrated Circuits, Prentice hall
   of India ltd, New Delhi.

**References:**

2. Resnick: Special theory of relativity
3. A.P French: Special relativity
5. C. Kittel: Introduction to solid state physics
6. A J. Dekkar: Solid State physics
7. J.B. Blackmore: Introduction to solid state physics
8. S V Subramanyam : Experiments in Electronics
9. R P Jain: Modern Digital Electronics
10. Malvino and Leach: Digital principles and applications
11. Grob B: Basic Electronics
12. Boylestead: Network analysis

**18PHY316 ATOMIC AND MOLECULAR PHYSICS 3- 0- 0 3**

**Objective:** To enable students to apply the basic knowledge of classical and quantum
mechanics at the atomic and molecular level.
Unit I


Unit II

**Atomic Spectra** (16 hrs)

**The Electron:** Determination of e/m of an electron by Thomson method, Determination of charge of an electron by Millikan’s oil drop method.

**Atomic Spectra:** Inadequacy of Bohr atomic model, correction due to finite mass of the nucleus, Rydberg constant in terms of reduced mass, Excitation and Ionisation potentials, Franck-Hertz experiment, Bohr-Sommerfeld Model of atom, vector model of an atom, Electron spin, space quantisation, magnetic moment of an electron due to its orbital motion. Stern-Gerlach experiment and its theory.


Unit III

**Zeeman effect:** Introduction, experimental study of normal Zeeman effect, theory of normal Zeeman effect, expression for Zeeman effect, quantum theory of normal Zeeman effect, anomalous Zeeman effect, Paschen-Back effect and Stark effect.

Unit IV

**Molecular Spectra** (10 hrs): Molecular formation, the H molecular ion, H₂ – molecule. Salient features of molecular spectra.

Rotation, vibration and electronic spectra of molecules, associated quantum numbers and selection rules. Theory of pure rotation and rotation- vibration spectra, Raman and IR spectra, simple applications.

Unit V

**Electromagnetic Theory And Maxwell’s Equations** (12 hrs.) : Displacement current, Setting up of Maxwell’s equations in SI units, Hertz experiment, Travelling electromagnetic wave, Wave equations (qualitative and quantitative) – Energy transport and Poynting vector, Poynting theorem. A radiation pressure (Normal and Oblique incidence). Concept of electric dipole, magnetic dipole, expression for energy radiated by a dipole (No derivation)

**Text books:**
1. Atomic and nuclear physics - Littlefield and T.V. Thorley
2. Molecular spectra – G Herzberg
3. Fundamental university physics, vol. 3 – Aloson and Finn

References:

1. Perspectives of Modern Physics Beiser.
2. Electromagnetism, Reitz and Milford.
5. Lasers – A K Gatak
6. Modern Physics - K.S. Krane
7. Introduction to modern Physics – H S Mani and G K Mehta

18PHY331 MEDICAL PHYSICS 3 0 0 3

Objective: To enable students to provide Medical Physics support with the goal of improving the effectiveness and safety in the use of Physics and technologies in medicine.

Unit I:

Unit II:
Acoustics of the body: Nature and characteristics of sound, Production of speech, Physics of the ear, Diagnostics with sound and ultrasound. Optical system of the body: Physics of the eye. Electrical system of the body: Physics of the nervous system, Electrical signals and information transfer.

Unit III:
X-RAYS: Electromagnetic spectrum, production of x-rays, x-ray spectra, Bremsstrahlung, Characteristic x-ray. X-ray tubes & types: Coolidge tube, x-ray tube design, tube cooling stationary mode, Rotating anode x-ray tube, Tube rating, quality and intensity of x-ray. X-ray generator circuits, half wave and full wave rectification, filament circuit, kilo voltage circuit, types of X-Ray Generator, high frequency generator, exposure timers and switches, HT cables, HT generation

Unit IV:
detectors, ionisation chamber, Dosimeters, survey methods, area monitors, TLD, Semiconductor detectors.

Unit V:

**Text Books:**

**References:**
- Christensen’s Physics of Diagnostic Radiology: Curry, Dowdey and Murry - Lippincot Williams and Wilkins (1990)
- The Physics of Radiology-H E Johns and Cunningham.

18PHY332 RENEWABLE ENERGY AND ENERGY HARVESTING 3 0 0 3

**Objective:** To enable students to understand the use of different sources of energy.

**Unit I:**

**Fossil fuels and Alternate Sources of energy:** Fossil fuels and Nuclear Energy, their limitation, need of renewable energy, non-conventional energy sources. An overview of developments in Offshore Wind Energy, Tidal Energy, Wave energy systems, Ocean Thermal Energy Conversion, solar energy, biomass, biochemical conversion, biogas generation, geothermal energy tidal energy, Hydroelectricity.

**Unit II:**

**Solar energy:** Solar energy, its importance, storage of solar energy, solar pond, non convective solar pond, applications of solar pond and solar energy, solar water heater, flat plate collector, solar distillation, solar cooker, solar green houses, solar cell, absorption air
conditioning. Need and characteristics of photovoltaic (PV) systems, PV models and equivalent circuits, and sun tracking systems.

Unit III:


Unit IV:


Hydro Energy: Hydropower resources, hydropower technologies, environmental impact of hydro power sources.

Piezoelectric Energy harvesting: Introduction, Physics and characteristics of piezoelectric effect, materials and mathematical description of piezoelectricity, Piezoelectric parameters and modeling piezoelectric generators, Piezoelectric energy harvesting applications, Human power

Unit V:

Electromagnetic Energy Harvesting: Linear generators, physics mathematical models, recent applications.

Carbon captured technologies, cell, batteries, power consumption

Environmental issues and Renewable sources of energy, sustainability.

References:

- Non-conventional energy sources - G.D Rai - Khanna Publishers, New Delhi
- Solar energy - M P Agarwal - S Chand and Co. Ltd.
Objective: To enable students to provide knowledge about nanotechnology and its applications in Physics by focusing on different areas.

Unit I:

Introduction: relation of nano to other sciences - chemistry, biology, astronomy, geology, nano in nature.

Unit II:

Properties of nano-materials: size effect, particle’s size, shape, and density, melting point, surface tension, gettability, surface area and pore, composite structure, crystal structure, surface characteristics; mechanical, electrical, properties, and optical properties.

Unit III:

Synthesis of nanoparticles: Classification of fabrication methods – top-to-bottom and bottom-to-top approaches, physical and chemical methods of preparation: CVD, controlled precipitation, sol-gel method, PLD etc; Confinement of particles - low dimensional structures - quantum wells, wires and dots.

Unit IV:

Characterisation of nanoparticles: X-Ray diffraction, examples of XRD, Debye-Scherzer formula; FTIR: principle, methodologies and accessories; SEM: basics and primary mode of operation, applications; TEM: basic principles; STM: basic principles and instrumentation; AFM: basics, modes of operation and applications; Photoluminescence: basic principles.

Unit V:

Application of nanophysics: Carbon nanostructures: Fullerenes, CNTs and their applications; MEMS and NEMS devices; Quantum Cascade Lasers, Smart materials, GMR and Spintronic, multifarious.
References:

4. S.V. Gaponenko, P.L Knight & A. Miller, Optical Properties of Semiconductor Nanocrystals, CUP, 1E, 2005
5. T Pradeep, Nano: The Essentials, TMH, 1E, 2007

**Objective:** To enable students to understand the atmosphere of Earth and the climate change.

**Unit I:**

**Earth - Atmosphere system** – Introduction, Composition and structure, Radiative equilibrium, Energy budget, General circulation, Historical perspectives, Weather & Climate

**Unit II:**

**Atmospheric thermodynamics** – Ideal gas law, First law of thermodynamics, Atmospheric composition, Hydrostatic balance, Entropy & potential temperature, Parcel concepts, Available potential energy, Moisture in the atmosphere, Saturated adiabatic lapse rate, Tephigram, Cloud formation
Atmospheric radiation – Basic physical concepts, Radiative transfer equation, basic spectroscopy of molecules, Transmittance, Absorption by atmospheric gases, Heating rates, Greenhouse effect revisited, Simple scattering model

**Unit III:**

**Basic fluid dynamics** – Mass conservation, material derivative, alternative form of continuity equation, equation of state for the atmosphere, Navier-Stokes equation, Rotating frames of reference, equations of motion in coordinate form, geostrophic and hydrostatic approximation, Pressure coordinates and geopotential, Thermodynamic energy equation; Atmospheric fluid dynamics – vorticity and potential vorticity, Boussinesq approximation, Quasi-geostrophic motion, Gravity waves, Rossby waves, Boundary layers, Instability

**Unit IV:**

**Stratospheric chemistry** – Thermodynamics and chemical reactions, Chemical kinetics, Bimolecular reactions, Photo-dissociation, Stratospheric ozone, Transport of chemicals, Antarctic ozone hole
Atmospheric remote sounding – Observations, remote sounding from space and ground; Atmospheric modeling – Hierarchy of models, Numerical methods, Uses of complex numerical models, Lab models

Unit V:

Climate change – Introduction, energy balance model, some solutions of the linearised energy balance model, Climatic feedbacks, Radiative forcing due to increase in Carbon dioxide.
Projects based on Modules 4 and 5 (Reading a journal paper & reproducing calculations, Numerical modeling and / or data analyses)

Textbooks/References
3. Holton JR: An introduction to Dynamic Meteorology, 4E, AP, 2004

18PHY335 BIOPHYSICS 3 0 0 3

Objective: To enable students to study the selected biological phenomena using physical principles.

Unit I:

Unit II:

Spectroscopy: UV spectroscopy, circular dichroism, Fluorescence spectroscopy, IR, Raman and Electron spin spectroscopy, NMR spectroscopy.

Unit III:

Molecular Modeling & Macromolecular Structure: building the structure of H2O2, , nucleic-acid structure, monomers, polymers, double helical structure of DNA, Polymorphism andnanostructure of DNA, structure of RNA, protein structure: amino acids, virus structure

Unit IV:

**Unit V:**

**Neurobiophysics:** nervous system, physics of membrane potentials, sensory mechanisms. Origin and evolution of life: prebiotic earth, theories of origin and evolution of life, laboratory experiments on formation of small molecules.

**Textbooks:**

**Objective:** To enable students to study in detail about physics and kinematics of the planetary bodies.

**Unit I:**

Brief history of solar-terrestrial physics – The variables Sun and the heliosphere. Earth’s space environment and upper atmosphere.

**Unit II:**


**Unit III:**

Solar wind & Interplanetary Magnetic Field(IMF), Shocks and Instabilities in space.

**Unit IV:**

Solar wind interactions with magnetised planets – Introduction, planetary magnetic fields, spherical harmonic expansions, geomagnetic field and its measurements, variations in Earth’s field.

**Unit V:**
Magnetosphere – Dynamics, Sw-Magnetosphere interactions; Ionosphere, Currents in space and Ionosphere; Neutral – Dynamics.

References:


18PHY381 PRACTICALS 0-1-2 2

(A minimum of ten experiments to be performed from the following list)
1. Junction diode characteristics
2. Zener diode characteristics
3. Junction Transistor characteristics
4. FET characteristics
5. Wien Bridge Oscillator.
6. UJT characteristics.
7. Full adder using AND, OR and XOR gates
8. Study of op-amp characteristics.
9. Measurement of efficiency and output power of LED.
10. Verification of the inverse square law for light intensity using a phototransistor.
13. Amplitude demodulator.
14. Logic gates – AND, OR, NOT, NOR and XOR using IC 7402

18PHY382 PRACTICALS 0-1-2 2

(A minimum of eight experiments from the following)
1. Determination of Rydberg constant by studying the Fraunhoffer spectrum
2. Analysis of powder X ray photograph
3. Study of the characteristics and spectral response of a photocell (selenium photocell
4. Study of hydrogen spectrum
5. Analysis of band spectrum of PN molecule.
6. Analysis of rotational spectrum of nitrogen.
7. Analysis of rotational vibrational spectrum of a diatomic molecule (HBr).
8. Absorption spectrum of KMnO₄
9. Determination of dipole moment of an organic liquid

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