Dr. Poonam Tandon
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Department of Physics

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May 17, 2019
PD/LU/360/19

The Controller of Examinations,
Lucknow University,
Lucknow.

Through Proper Channel

Sub: Minutes of BOS meeting for UG and PG Syllabus.

Dear Sir,

I am herewith submitting the minutes of the meeting of the Board of Studies in Physics held on **May 17th 2019 at 11.00 a.m.**, regarding undergraduate and postgraduate syllabus.

Yours sincerely,

(Poonam Tandon)

Encls:

a. Attendance.
b. Minutes (with nine (09) annexures and total twenty three (23) papers.

MINUTES OF THE BOS MEETING

Place: HoD Room, Physics Department
Date: 17th May, 2019
Time: 11:00 a.m.

This meeting of the Board of Studies (BoS) of Physics is held to discuss the UG & PG syllabus. Attendance sheet of the BoS members is attached. After discussion, members recommended the following.

1. The BoS recommend revision in the format of courses to be taught in Semester I to VI (Annexure I)

2. The members of the BoS recommend revision in the syllabus for B.Sc. Semester I to IV (Annexure II to V).

3. The members of Board of Studies recommend the syllabus of Physics for B.Sc. Semester V and VI (Annexure VI & VII)

4. The BoS recommend that PG students should do the project/dissertation in the last semester. As such BoS recommend the revision in the format of courses to be taught in M.Sc. - Physics Semester I to IV (Annexure VIII).

5. The BoS recommends to revise the syllabus of the elective paper PHYE-105 (Annexure IX).

ATTENDENCE OF BoS MEETING

Place: HoD Room, Physics Department
Date: 17th May, 2019
Time: 11:30 a.m.

1. Prof. Poonam Tandon, HoD **(Chairperson)**
2. Prof. Kirti Sinha
3. Prof. N.K. Pandey
4. Prof. Onkar Prasad
5. Prof. Neeraj Misra
6. Prof. Manisha Gupta
7. Prof. R.K. Shukla
8. Prof. Balak Das 17/5/2019
9. Prof. M.M. Verma
10. Prof. Anchal Srivastava 17/5/19
11. Prof. Rajiv Manohar
12. Prof. A.K. Singh (on leave)
13. Prof. Leena Sinha
14. Dr. (Ms.) Navina Wadhwani
15. Dr. Daya Shanker
16. Dr. Aashees Awasthi
17. Dr. Jyotsana Singh
18. Dr. S.K. Pundir
19. Dr. Bhupesh Kumar 17.5.19
20. Δ Swayam Prakash Shukla, JNPG College
21. Δ Sanjay Misra, BSNV PG College 17/05/2019

B 2

PHYSICS

B.Sc. - Semester I to VI

Paper	Semester -I	Semester-II	Semester - III	Semester IV	Semester V	Semester VI
I	Mechanics and Wave Motion	Optics	Electricity & Magnetism	Thermal Physics and Elementary Statistical Mechanics	Electronics	Mathematical Methods and Numerical Techniques
II	Circuit Fundamentals and Basic Electronics	Practical	Practical	Elements of Modern Physics	Nuclear Physics	Elements of ~~Classical &~~ Relativistic & Classical Mechanics
III					Practical	Solid State Physics

Each paper carries 100 Marks (4 Credits)

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Annexure - I

Annexure II

B. Sc. - Semester I

PHYSICS

MECHANICS AND WAVE MOTION

(4 CREDITS) **PAPER – I** **(48 LECTURES)**

Unit - I

Inertial and non-inertial reference frames, radial and transverse components of velocity and acceleration using polar coordinates, Newton's laws of motion. Dynamics of particle in rectilinear and circular motion, Conservative and Non-Conservative forces, conservation of energy, linear momentum, and angular momentum. Collision in one and two dimensions, cross section.

Unit - II

Rotational energy and rotational inertia for simple bodies (ring, disk, rod, solid and hollow sphere, cylinder, rectangular lamina). The combined translational and rotational motion of a rigid body on horizontal and inclined planes. Simple treatment of the motion of a top. Relations between elastic constants, bending of beam and torsion of cylinder.

Unit - III

Central forces, Two body central force problem, Reduced mass and its equation of motion, Centre of mass motion, Newton's law of gravitation; Gravitational binding energy, Equivalence of inertial and gravitational mass, Gravitational field and potential at a point inside and outside a hollow and solid sphere. Kepler's laws, motion of planets and satellites, geo-stationary satellites.

Unit- IV

Differential equation of Simple Harmonic Motion (SHM) and its solution, use of complex notation, damped and forced oscillations, Quality factor. Composition of simple harmonic motion, Lissajous figures. Differential equation of wave motion, plane progressive waves in fluid media, reflection of waves, phase change on reflection, Principle of superposition of waves, stationary waves, pressure and energy distribution, phase and group velocity.

Reference books:

~~Unit I-III~~

1. Berkeley Physics Course Vol I: Mechanics –C. Kittel et al.(McGraw Hill 2017)
2. Feynman Lectures in Physics Vol I – Feynman, Leighton and Sands (Addison–Wesley 2005)
3. Physics Vol I – Resnick, Halliday and Walker (Wiley India Pvt. Ltd. 2007)
4. University Physics – Sears, Zemansky and Young (Pearson 1973)

~~Unit IV~~

5. Vibrations and Waves – A. P. French (CRC Press, 1971)
6. Vibrations and Waves in Physics– I. G. Main (Cambridge University Press, 1993)
7. Berkeley Physics Course Vol 3: F.S.Crawford .(McGraw Hill 2011)
8. Mechanics : R.K. Shukla and Anchal Srivastava – New Age International (P) Ltd Publishers
9. How and Why in Basic Mechanics Arvind Kumar and Shirish Barve University Press 2013.

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B. Sc. – Semester I

PHYSICS

CIRCUIT FUNDAMENTALS AND BASIC ELECTRONICS

(4 CREDITS) **PAPER – II** **(48 LECTURES)**

Unit - I

Growth and decay of current through inductive resistances (LR circuit), charging and discharging of capacitor through resistance (CR circuit) and inductive resistance (LCR circuit) , time constant, Measurement of high resistance by leakage method.
Alternating current in RLC circuits, method of imaginaries, complex impedance, phase diagrams, Q factor, series and parallel resonant circuits, theory of coupled circuits, Transformers, Reflected Impedance and impedance matching, Maximum power transfer theorem. AC bridges: Maxwell, Schering and Wien.

Unit - II

Semiconductors: Covalent bonding, Energy bands, Forbidden energy gap, Intrinsic and extrinsic semiconductors, p-type and n-type semiconductors. Formation of the pn junction. Depletion layer, Field and potential at the depletion layer (qualitative only). Unbiased diode, Forward and Reverse biased diodes, Current conduction in a pn junction, majority and minority carriers. Characteristic curves. Static (DC) and Dynamic (AC) resistance.
Diode as a rectifier, Half wave, Full wave and Bridge rectifier. Rectification Efficiency and Ripple factor. Zener and Avalanche breakdown. Zener diode as a voltage regulator. Filter Circuits: Choke input filter, Capacitor input filter, L and π type filters; DC Power supply, Bipolar transistors: PNP and NPN transistors, their characteristic curves in common base, common emitter and common collector configurations, Active, Cut-off and Saturation regions, DC alpha and DC beta and relationship between them.

Unit - III

Transistor biasing: Need for biasing, Transistor biasing circuits: Base Bias, Emitter Bias, Voltage Divider Bias. Transistor leakage currents, thermal runaway, transistor stabilization, swamping, Stability factor. Load line, DC and AC load line, Operating point. DC and AC equivalent circuits. Low frequency transistor models, small signal amplifiers, Common Base, Common Emitter, Common Collector amplifier, Current and Voltage gain, RC coupled amplifier, Qualitative treatment, Study of frequency response of RC coupled amplifier.

Unit - IV

Feedback in amplifiers: Positive and Negative feedback, Input and Output Impedance of Negative feedback voltage amplifiers. Transistor as an oscillator, Tank circuit, Barkhausen criterion, General discussion and theory of Hartley oscillator. Elements of transmission and reception, Basic principle of amplitude modulation and demodulation, principle and design of linear multimeters and their applications, Cathode ray Oscilloscope and its simple applications.

Reference Books:

~~Unit I~~ :

1. Electric Circuit Fundamentals – T.M. Floyd and D. M. Buchla (Pearson 2008)

~~Unit II – IV~~

2. Electronic Principles – A. P. Malvino (McGraw-Hill 1998)
3. Transistor circuit approximations – A. P. Malvino (McGraw-Hill 1980)
4. Electronic Devices and Circuits – Millman and Halkias (McGraw Hill Education 1967)

Annexure - III

B. Sc.- Semester II

PHYSICS

OPTICS

(4 CREDITS) PAPER – I (48 LECTURES)

Unit - I

Introduction to waves, Huygen's principle, Interference of two beams of light, Conditions for interference, Spatial and temporal coherence, classification of interference, Division of Wavefront: Fresnel's Biprism, Lloyd's Mirror. Division of amplitude: Newton's rings, Michelson's Interferometer, Fringes of equal inclination, Fringes of equal thickness, Interference involving multiple reflections, Stokes' treatment, interference in transmitted light, Fabry-Perot interferometer, Edser- Butler interferometer.

Unit - II

Fresnel and Fraunhofer Diffraction, Diffraction by a single and double slits. Derivation of equation for intensity, comparison of single-slit and double slit patterns, distinction between interference and diffraction, missing orders. Diffraction grating, formation of spectra by a grating, principal maxima, difference between spectra of prism and grating, production of ruled grating.

Unit - III

Rayleigh's criterion of resolution, Resolving power of a Grating, Resolving power of a telescope, Fresnel's half period zones, diffraction at a straight edge, diffraction at a narrow wire, Zone plate. Polarization, polarization by reflection, Brewster's law, Law of Malus, Polarization by dichroic crystals, birefringence, anisotropic crystals, Nicol prism, Retardation plates, Babinet compensator, Analysis of polarized light.

Unit - IV

Optical activity and Fresnel's explanation, Laurent Half shade and Biquartz polarimeters, Jones matrix, matrix representation of plane polarized waves, matrices for polarizers, retardation plates and rotators; Sources of light: Incoherent (Sodium, Neon, Mercury) and coherent (Laser-simple treatment).
Introduction to LASER, Introduction to optical fiber.

Reference books

1. Principles of Optics – Born and Wolf (Pergamon Press 1970)
2. Optics – F.W. Sears (Addison-Wesley 1975)
3. Fundamentals of Optics – Jenkins and White (McGraw Hill Education, 2017))
4. Optics - A. K. Ghatak (McGraw Hill Education 1992)
5. Introduction to Optics: Anchal Srivastava, R.K. Shukla and T.P. Pandya, New Age International (P) Limited Publishers
6. Introduction to Optical Fibers and its applications: RK Shukla LAP LAMBERT Academic Publishing

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B.Sc. - Semester II (July 2019 onwards)

PHYSICS PRACTICALS

(4 CREDITS) PAPER-II (48 LECTURES)

1. To determine g by compound pendulum
2. To determine the modulus of rigidity of material of a wire by statical method.
3. To determine the Young modulus of the material of a beam by flexure
4. To determine the frequency of AC mains
5. To determine the wavelength of light by Newton's rings
6. To determine the wavelength of sodium light by Fresnel biprism
7. To determine the diameter of a wire by diffraction
8. To determine the wavelength of mercury lines using transmission grating
9. To verify Brewster's law
10. To determine the specific rotation of an optically active substance by polarimeter

Reference Books:

4. Practical Physics: R.K. Shukla and Anchal Srivastava, New Age International (P) Limited Publishers

1. Advanced Practical Physics for students: B.L. Flint and H.T. Worsnop 1971, Asia Publishing House
2. A Text Book of Practical Physics: I. Prakash & Ramakrishna, 11th Ed. 2011, Kitab Mahal.
3. Practical Physics: G.L. Squires, 2015, 4th Edition Cambridge University

Annexure IV

Annexure IV

B.Sc. - Semester III

PHYSICS

ELECTRICITY AND MAGNETISM

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(4 CREDITS) PAPER-I (48 LECTURES)

Unit - I

Electrostatics: Electric Field and Lines, Electric Field **E** due to a Ring of Charge. Electric Flux; Gauss's law, Gauss's law in Differential form. Applications of Gauss's Law : **E** due to (1) an Infinite Line of Charge, (2) a Charged Cylindrical Conductor, (3) an Infinite Sheet of Charge and Two Parallel Charged Sheets, (4) a Charged Spherical Shell, (5) a Charged Conducting Sphere, (6) a Uniformly Charged Sphere, (7) Two Charged Concentric Spherical Shells and (8) a Charged Conductor. Force on the Surface of a Charged Conductor and Electrostatic Energy in the Medium surrounding a Charged Conductor. Electric Potential: Line Integral of Electric Field. Electric Potential Difference and Electric Potential V (Line integral). Conservative Nature of Electrostatic Field. Relation between **E** and V. Electrostatic Potential Energy of a System of Charges. Potential and Electric Field of (1) a Dipole, (2) Quadrupole (3) a Charged Wire and (4) a Charged Disc. Force and Torque on a Dipole. Conductors in an Electrostatic Field. Description of a System of Charged Conductors. An Isolated Conductor and Capacitance. Electrostatic Energy of (1) a Point Charge, (2) a System of Point Charges, (3) a Uniform Sphere, (4) a Capacitor.

Unit - II

Magnetism: Magnetostatics: Magnetic Effect of Currents, Magnetic Field **B**. Magnetic Force between Current Elements and Definition of **B.** Magnetic Flux. Biot-Savart's Law : **B** due to (1) a Straight Current Carrying Conductor, (2) Current Loop and (3) Solenoid. Current Loop as a Magnetic Dipole and its Dipole Moment (Analogy with Electric Dipole). Ampere's Circuital law (Integral and Differential Forms): B due to (1) a Solenoid and (2) a Toroid. Properties of **B.** Curl and Divergence of **B.** Vector Potential. Forces on an Isolated Moving Charge. Magnetic Force on a Current Carrying Wire. Torque on a Current Loop in a Uniform Magnetic Field. Magnetic Properties of Matter: Gauss's law of magnetism (Integral and Differential Forms). Magnetization current. Relative Permeability of a Material. Magnetic Susceptibility. Magnetization Vector (**M**). Magnetic Intensity (**H**). Relation between **B**, **M** and **H**. Stored Magnetic Energy in Matter. Magnetic Circuit. B-H Curve and Energy Loss in Hysteresis.

Unit - III

Electromagnetic Induction: Faraday's laws of Electromagnetic Induction, Lenz's Law, Self and Mutual Inductance, L of Single Coil, M of Two Coils. Energy Stored in Magnetic Field. Skin effect. Motion of Electron in Changing Magnetic field , Betatron , Magnetic Energy in Field , Induced Magnetic Field (Time Varying Electric Field), Displacement current.

Ballistic Galvanometer: Potential Energy of a Current Loop. Ballistic Galvanometer: Current and Charge sensitivity. Electromagnetic Damping. Logarithmic Damping.

Unit - IV

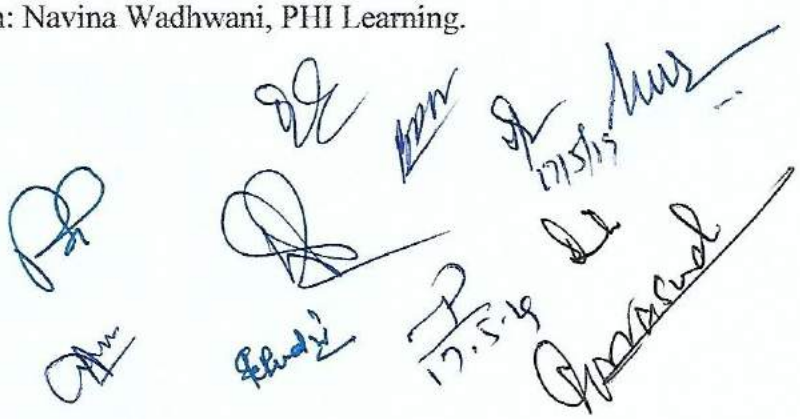
Dielectrics: Electric Field in Matter. Dielectric Constant. Parallel Plate Capacitor with a Dielectric. Polarization, Polarization Charges and Polarization Vector. Electric Susceptibility. Gauss's law in

Dielectrics. Displacement Vector **D**. Relations between the three Electric Vectors. Capacitors filled with Dielectrics. Electrostatic equation with dielectrics, Field , Force and Energy in Dielectrics.

Maxwell's equations and Electromagnetic wave propagation: Equation of Continuity of Current, Displacement Current, Maxwell's Equations, Poynting vector, Energy Density in Electromagnetic Field, Electromagnetic Wave Propagation through Vacuum and Isotropic Dielectric Medium, Transverse nature of EM Waves.

Suggested Books:

1. Electricity and Magnetism By Edward M. Purcell (McGraw-Hill Education, 1986)
2. Fundamentals of Electricity and Magnetism By Arthur F. Kip (McGraw-Hill, 1968)
3. Electricity and Magnetism by J.H.Fewkes & John Yarwood. Vol. I (Oxford Univ. Press, 1991).
4. Electricity and Magnetism. By D C Tayal (Himalaya Publishing House,1988).
5. David J. Griffiths, Introduction to Electrodynamics, 3rd Edn, (Benjamin Cummings,1998).
6. Electricity and Magnetism: Navina Wadhwani, PHI Learning.



B.Sc. - Semester III

PHYSICS PRACTICALS

(4 CREDITS) PAPER-II (48 LECTURES)

1. To study the time constant in a C.R. Circuit.
2. To study the solid state common power supply.
3. To determine the field along the axis of Helmholtz coil.
4. To measure magnetic field using a ballistic galvanometer.
5. To determine the capacity of condensor by absolute method.
6. To determine the coefficient of mutual induction between two coils.
7. To determine high resistance by leakage method.
8. To study the characteristics of junction and Zener diodes.
9. To Study the Characteristics of p-n-p transistor.
10. To measure 'L' & 'C' by A.C. bridge

Reference Books

* 4. Practical Physics (Electricity, Magnetism and Electronics): Anchal Srivastava and R.K. Shukla, New Age International (P) Limited Publishers

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

2. A Text Book of Practical Physics: I. Prakash & Ramakrishna 11th Ed, 2011, Kitab Mahal

3. Practical Physics: G.L. Squires, 2015, 4th Edition, Cambridge University Press.

Annexure V

Annexure V

B.Sc. - Semester IV

PHYSICS

THERMAL PHYSICS AND ELEMENTARY STATISTICAL MECHANICS

(4 CREDITS) **PAPER-I** **(48 LECTURES)**

Unit I

Thermodynamics: Zeroth Law of thermodynamics and temperature. First law and internal energy, conversion of heat into work, Various Thermodynamical Processes, Applications of First Law: General Relation between C_p & C_v, Work Done during Isothermal and Adiabatic Processes, Compressibility & Expansion Coefficient, Reversible & irreversible processes, Second law & Entropy, Carnot 's cycle & theorem, Entropy changes in reversible & irreversible processes. Clausius Inequality, entropy and unavailable energy, Entropy-temperature diagrams, Third law of thermodynamics, Unattainability of absolute zero.

Thermodynamic Potentials: Enthalpy, Gibbs, Helmholtz and Internal Energy functions, Maxwell's relations & applications - Joule-Thompson Effect, Clausius-Clapeyron Equation, Expression for $(C_P - C_V)$, CP/CV, TdS equations.

Unit II

Kinetic Theory of Gases: RMS speed, Kinetic Interpretation of temperature, Degree of Freedom, Law of equipartition of energy (no derivation) and its applications to specific heat of gases; mono-atomic and diatomic Gases. Mean free path, Transport Phenomena: Viscosity, Conduction and Diffusion (for vertical case), Derivation of Maxwell's law of distribution of velocities and its experimental verification.

Unit III

Theory of Radiation: Blackbody radiation, Spectral distribution, Concept of Energy Density, Derivation of Planck's law, Deduction of Wien's distribution law, Rayleigh-Jeans Law, Stefan Boltzmann Law and Wien's displacement law from Planck's law. Solar Constant.

Unit IV

Statistical Mechanics: Phase space, Macrostate and Microstate, Entropy and Thermodynamic probability, Maxwell-Boltzmann law - distribution of velocity -Quantum statistics - Fermi-Dirac distribution law - electron gas - Bose-Einstein distribution law - photon gas - comparison of three statistics.

Suggested books:

1. Thermal Physics - S. Garg, R. Bansal and C. Ghosh (McGraw Hill Education 1993)
2. A Treatise on Heat - Meghnad Saha, and B.N. Srivastava (Indian Press 1969)
3. Thermodynamics - Enrico Fermi (Dover Publications, 2013)
4. Heat and Thermodynamics - M.W.Zemasky and R. Dittman (McGraw-Hill College 1996)
5. Thermodynamics, Kinetic theory & Statistical thermodynamics - F.W.Sears & G.L.Salinger (Pearson 1975)
6. Statistical and Thermal Physics - S.Loknathan and R.S.Gambhir (BPB Publications, Delhi)

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B.Sc. - Semester IV

PHYSICS

ELEMENTS OF MODERN PHYSICS

(4 CREDITS) **PAPER-II** **(48 LECTURES)**

Unit I

Inadequacies of classical mechanics, Photoelectric Effect, The Quantum Theory of Light, Continuous and characteristic X-ray, X-ray generation and uses, Compton effect, Gravitational Red Shift, de Broglie waves, de Broglie Wave Function and its Properties, Interpretation of wave function, de Broglie Wave Velocity, Complementary principle, Principle of superposition, Wave and Group Velocity, Motion of Wave Packets Davisson and Germer Experiment-Diffraction of Electrons, Wave-particle duality Experiment.

Unit II

Heisenberg's Uncertainty principle and its applications, Estimating minimum energy of a confined particle using uncertainty principle, Estimate of Hydrogen Ground State Energy; Wave Equation, Wave Equivalent of an unrestricted Particle, Time Dependent Schrödinger wave equation: Eigenvalues and Eigen Functions, Probability Current; Expectation values, Expectation Values of Energy and Momentum Operators, Ehrenfest theorem.

Unit III

Continuity of wave Function, Boundary Condition and Discrete Energy Levels, Steady State Schrödinger Equation, Application of Schrödinger Wave Equation for Particle in an infinitely Rigid Box: Energy and Momentum Quantization, Normalization, Quantum Dot as an example; One Dimensional Step Potential, Rectangular Barrier, Square Well Potential.

Unit IV

Bohr atomic model, de Broglie Waves and Stationary Orbits, Hydrogen Atom Spectrum, Atomic Excitation-Franck Hertz Experiment, Correspondence Principle, Sommerfeld Elliptic Orbits. Electron Angular Momentum, Space Quantization, Electron Spin and Spin Angular Momentum, Spin Magnetic Moment, Stern – Gerlach Experiment, Pauli's Exclusion Principle and Periodic Table. Fine structure, Spin Orbit Coupling, Spectral Notation for Atomic States, Total Angular Momentum, Vector Model, Coupling schemes (LS and jj) for two electron systems. Zeeman Effect for one Electron System. 12

Suggested Books:

1. Concepts of Modern Physics- Arthur Beiser (McGraw-Hill, 2009).
2. Modern Physics- John R. Taylor, Chris D. Zafiratos, Michael A.Dubson (PHI Learning2009).
3. Six Ideas that Shaped Physics: Particles Behave like Waves, Thomas A. Moore, (McGraw Hill, 2009).
4. Modern Physics - R.A. Serway, C.J. Moses, and C.A. Moyer (Third Edition, 2005, Cengage Learning
5. A Text book of Quantum Mechanics- P.M. Mathews & K. Venkatesan (2nd Ed., 2010, McGraw Hill).

6. Quantum Mechanics: Theory and Applications - Ajoy Ghatak, S. Lokanathan.(Macmillan Publishers India Limited).
7. Fundamentals of Modern Physics - R.M. Eisberg (Wiley, New York)
8. Introduction to Atomic Spectra -H.E. White,(McGraw-Hill, New York).
9. Quantum Mechanics, Atomic and Molecular Spectra: R.K. Shukla and Anchal Srivastava, New Age International (P) Limited Publishers
10. Essentials of Group Theory Quantum Mechanics and Spectroscopy (2004) V.P. Gupta & Poonam Tandon

Annexure VI

B. Sc. - Semester V

Annexure VI

PHYSICS

ELECTRONICS

(4 CREDITS) **PAPER – I** **(48 LECTURES)**

Unit – I

Diodes: Junctions between metal and semiconductors; Semiconductor properties: P. N. junction, depletion layer, Diode equation, junction potential width of depletion layer (qualitative only), field and capacitance of depletion layer, Effect of temperature on Junction diode, AC and DC resistances, reverse breakdown of PN junction; Zener and Avalanche diodes; Tunnel diode; Point contact diode; Light emitting diodes (LEDs); Photodiodes, Thermistors.

Unit - II

Transistors: Transistor parameters, base width modulation, Emitter resistance, Collector conductance, Current and Voltage gain, Biasing formulae for transistors, Base bias, emitter bias and mixed type bias, Input and Output Characteristics of CB, CE and CC Configurations. Transistor circuit application at law frequencies, their AC and DC equivalent for three different modes of operation, large signal operation of transistors. Transistor Power amplifiers: Class A and B operation, maximum power output, effect of temperature, Distortion in amplifiers, cascading of stages, Frequency response, Negative and positive feedback in transistor amplifiers.

Unit- III

Field Effect Transistors: JFET, Construction, Idea of Channel Formation, Pinch-Off and Saturation Voltage, Current-Voltage Output Characteristics. MOSFET, types of MOSFETs, Circuit symbols, Working and Characteristic curves of Depletion type MOSFET (both N channel and P Channel) and Enhancement type MOSFET (both N channel and P channel). Complimentary MOS (CMOS)
Power Devices: Unijunction transistors (UJT), basic construction and working, Silicon controlled rectifier (SCR) construction, working and characteristics, Triac, Diac, IGBT, MESFET, operation and applications.

Unit- IV

Number System and Codes: Decimal, Binary, Hexadecimal and Octal number systems, base conversions, Binary, octal and hexadecimal arithmetic (addition, subtraction and multiplication), representation of signed and unsigned numbers, Binary Coded Decimal codes. 14

Logic Gates and Boolean algebra: Introduction to Boolean Algebra and Boolean operators, Truth Tables of OR, AND, NOT, Basic postulates and fundamental theorems of Boolean algebra, Truth tables, construction and symbolic representation of XOR, XNOR, Universal (NOR and NAND) gates. Digital Logic families: Fan-in, Fan out, Noise Margin, Power Dissipation, Figure of merit, Speed power product, TTL and CMOS families and their comparison.

Reference books:

1. Semiconductor Devices: Kanaan Kano
2. Basic Electronic Devices and Circuits: R. Y. Borse
3. Electronic Devices and Circuits: S. Rama Reddy
4. Electronic Principles: A P Malvino
5. Digital Principles and Application: Leach & Malvino
6. Electronics: Fundamentals and Applications: D. Chattopadhyay & P.C. Rakshit

B.Sc. - Semester V

PHYSICS

NUCLEAR PHYSICS

(4 CREDITS) **PAPER – II** **(48 LECTURES)**

Unit - I

General Properties of Nucleus: Brief survey of general properties of the nucleus; Mass, Mass defect, Binding energy, Main features of binding energy versus mass number curve, N/Z plot, Nuclear charge and mass distribution, Size, Spin and Parity. Nuclear Magnetic dipole moment, Electric quadrupole moment and Nuclear shape.

Nuclear forces and two-nucleon system: Deuteron ground state and excited states. Nucleon-Nucleons scattering: Basic idea of scattering cross section, n-p and p-p scattering (qualitative only), Basic characteristics of Nuclear force, Elementary discussion on Yukawa's theory of nuclear force.

Unit - II

Nuclear Models: Need for nuclear models, Fermi gas model, Liquid drop model, Bethe–Weizsäcker mass formula, Single particle Shell model (only the level scheme in the context of reproduction of magic numbers). Collective model, Nuclear Vibrational and Rotational states. (qualitative)

Natural Radioactivity: Alpha decay and its energy spectrum, Q-value for alpha decay, Theory of alpha decay - Quantum tunnelling. Beta decay and its energy spectrum, Q-value for beta decay, Need for the neutrino, Fermi's theory of beta decay (qualitative), Non-conservation of Parity in beta decay (qualitative), Gamma decay, Selection rules for gamma transitions (no derivation).

Unit - III

Nuclear Reactions: Nuclear reactions and their conservation laws, Q value for nuclear reaction, Cross section of nuclear reactions, Theory of Fission, Nuclear fusion (qualitative), and nuclear reactors.

Accelerators and detectors: Van de Graff, Cyclotron and Synchrotron, Basic idea of Large Hadron Collider (LHC) and future Colliders, Interaction of charged particles and gamma rays with matter: Mechanism, Ionization formula, Stopping power and range, Radiation detectors: GM counter, Scintillation counter and Neutron detectors.

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Unit - IV

Elementary Particles: Basic interactions and their mediating quanta, Types of particles and their families, Basic concept of Feynman diagrams. Symmetries and Conservation Laws (Noether's theorem): Energy and Momentum, Angular momentum, Parity, Baryon number, Lepton number, Isospin, Strangeness, Hypercharge. Basic concept of Quark model, Origin of mass of elementary particles (B.E.H Field mechanism). (qualitative).

Suggested books:

1. Introductory nuclear Physics: Kenneth S. Krane (Wiley India Pvt. Ltd., 2008).
2. Introduction to the physics of nuclei & particles: R.A. Dunlap. (Thomson Asia, 2004).
3. Nuclear Physics: S.N. Ghoshal, S. Chand & Company Ltd.
4. Nuclear Physics an Introduction: S.B. Patel, New Age International (P) Limited.
5. Introduction to Elementary Particles: D. Griffith, John Wiley & Sons.
6. Quarks and Leptons: F. Halzen and A.D. Martin, Wiley India, New Delhi.
7. Basic ideas and concepts in Nuclear Physics - An Introductory Approach:K. Heyde (IOP- Institute of Physics Publishing, 2004).
8. Radiation detection and measurement: G.F. Knoll (John Wiley & Sons, 2000).

B.Sc. - Semester V

PHYSICS PRACTICALS

(4 CREDITS) PAPER-III (48 LECTURES)

1. To study the characteristics of Field Effect Transistor
2. Study of FET as a Voltage Variable Resistor(VVR) and application of FET as a VVR in Voltage Controlled Attenuator (VCA)
3. To study the effect of voltage and current feedback on frequency response of RC Coupled transistor amplifier
4. Study of IC amplifier
5. Study of Logic Gates /
6. To determine the forbidden energy gap of a semiconductor with the help of a diode
7. To determine the velocity of sound by CRO
8. To determine Stefan's constant
9. To study resonance in series and parallel LCR circuit
10. To determine the Hall coefficient, the carrier concentration and the mobility in a semiconductor crystal

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Reference Books:

1. Advanced Practical Physics for students: B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. A Text Book of Practical Physics: I. Prakash & Ramakrishna 11th Ed, Kitab Mahal
3. A Laboratory Manual of Physics for undergraduate classes D.P. Khandelwal, 1985, Vani
4. Practical Physics: G.L. Squires, 2015, 4th Ed, Cambridge University Press.

Annexure VII

Annexure VII

B.Sc. - Semester VI

PHYSICS

MATHEMATICAL METHODS AND NUMERICAL TECHNIQUES

(4 CREDITS) **PAPER – I** **(48 LECTURES)**

Unit-1

Complex numbers and their polar form, Properties of moduli and arguments, Regions in the complex plane, Continuity and differentiability of complex functions, Analytic (Regular) functions, The Cauchy - Reimann equations and its polar form, Laplace equation, Harmonic functions.

Unit-2

Initial and boundary value problems, Partial differential equation and variable separable method, Legendre's relation, Bessel function, Recurrence relations, Taylor and Laurent's series, Cauchy Integral formula.

Unit-3

Mean value theorem, physical application, Partial derivatives, Maxima and minima, Diffusion equation of heat flow- 1D, 2D, 3D, Fourier series, Convolution- Physical application, Fourier transform.

Unit-4

Numerical methods for solution of differential, partial differential and integral equations, Euler's method, Runge - Kutta method, Numerical Integration, Differentiation, Simpson's rule -1/3, 1/8, Newton Raphson method, Gauss quadratic formula.

Suggested books:

1. Mathematical Methods for Physicists: Arfken, Weber, 2005, Harris, Elsevier.
2. Fourier Analysis: M.R. Spiegel, 2004, Tata McGraw-Hill.
3. Mathematics for Physicists: Susan M. Lea, 2004, Thomson Brooks/Cole.
4. An Introduction to Ordinary Differential Equations: E.A Coddington, 1961, PHI Learning
5. Differential Equations: George F. Simmons, 2006, Tata McGraw-Hill.
6. Essential Mathematical Methods: K.F. Riley and M.P. Hobson, 2011, Cambridge University Press
7. Introduction to Numerical Analysis: S.S. Sastry, 5th Edn., 2012, PHI Learning Pvt. Ltd.

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8 • Numerical Recipes in C++: The Art of Scientific Computing, W.H. Press et.al., 2nd Edn., 2013, Cambridge University Press.
9 • A first course in Numerical Methods: U.M. Ascher & C. Greif, 2012, PHI Learning.
10 • An Introduction to computational Physics:T.Pang,2nd Edn., 2006,CambridgeUniv. Press

B.Sc. - Semester VI

PHYSICS

SOLID STATE PHYSICS

(4 CREDITS) **PAPER-III** **(48 LECTURES)**

Unit – I

Lattice, basis, translation vectors, Primitive Lattice cell, Two and three-dimensional lattice types, Symmetry operations, Point groups and space groups, Miller indices, Simple crystal structures, NaCl, CsCl, diamond, Cubic ZnS and hexagonal ZnS, glasses.

X-Ray Diffraction, Bragg law, Experimental X-ray diffraction methods- Laue, Rotating-crystal, Powder. Derivation of scattered wave amplitude, Fourier analysis, Reciprocal lattice, Ewald method, Brillouin zones, Fourier analysis of the basis- structure and form factor.

Unit – II

Crystal of inert gases, Van der Walls-London interaction repulsive interaction, Cohesive energy, Ionic crystal, Madelung constant, Covalent crystals, Hydrogen-bonded crystals.

Lattice Heat capacity, Einstein and Debye theories of specific heat of solids, T^3 law Vibrations of monatomic and diatomic lattices, derivation of dispersion relation, Phonon momentum.
Free electron theory, density of states, Drude Model , Sommerfeld's; Wiedmann-Franz law, Heat capacity of electron gas, Paramagnetic susceptibility of conduction electrons, Hall effect in metals.

Unit – III

Origin of band theory, Bloch theorem, Kronig-Penney model, Effective mass, Concept of holes, p and n type semiconductors - mobility, Hall Effect. The upper filled band and the conduction band in ionic crystals , Excitons, Qualitative discussion of lattice defects and their influence on electronic levels, Colour centers, Luminescence, thallium activated alkali halides

Unit – IV

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Dielectric Properties of Materials: Polarization. Local Electric Field at an Atom. Depolarization Field. Electric Susceptibility. Polarizability. Clausius Mosotti Equation. Classical Theory of Electric Polarizability. Normal and Anomalous Dispersion. Plasma optics, Plasma Frequency, Plasma Oscillations, Plasmons, Superconductivity, Introduction to High T_c Superconductor.

Reference books:

1. Introduction To Solid State Physics: Charles Kittel
2. Solid State Physics: Adrianus J. Dekker.
3. Solid State Physics: Ashcroft and Mermin
4. Introduction to solids: Leonid V. Azároff

B. Sc. - Semester VI
PHYSICS
ELEMENTS OF RELATIVISTIC AND CLASSICAL MECHANICS

(4 CREDITS) **PAPER-II** **(48 LECTURES)**

Unit - I

Michelson-Morley experiment and its consequences. Notion of relativity of electric and magnetic effects and rejection of absolute motion, Einstein's postulates of special theory of relativity. Lorentz transformations; their orthogonality and homogeneity. Relativity of simultaneity, Lorentz contraction, Time dilation. Resolution of Twin Paradox, Relativistic Doppler effect, Relativistic addition of velocities and rapidities. Motion under a constant force. Variation of mass with velocity, zero rest mass particle.

Unit - II

Spacetime diagrams for frames in relative motion. Light cones. Four-interval, Time-like, space-like and light-like intervals. Invariance under Lorentz transformations, Difference between invariant and conserved quantities, Mass energy equivalence, Relation between energy and momentum, Four-momentum and its conservation. Basics of general theory of relativity. Equivalence principle. Basic concept of Schwarzschild metric, gravitational redshift, bending of light, gravitational waves.

Unit - III

Holonomic and non-holonomic constraints. Principle of virtual work, Lagrange's equations from D'Alembert's principle, Degrees of freedom, Generalized coordinates. Hamilton's principle and its role in Lagrangian formulation, Lagrangian of a relativistic free particle. Generalized momentum. Cyclic coordinates. Conservation laws and spacetime symmetries. Calculus of variation and its applications, brachistochrone problem. Hamiltonian formulation and Hamilton's equations of motion.

Unit - IV

Two-body central force problem. Reduced mass from Lagrangian, Derivation of orbits from first integrals of equations of motion, and from Hamilton-Jacobi equation, Classification of orbits—closed, open, bounded, unbounded motion. Importance of inverse square law force. Planetary orbits as circular hodographs, Isochronous potentials, Kepler's problem in velocity space, Inadequacy of Classical Mechanics, Virial theorem and its applications. Action-angle variables for one-dimensional periodic motion.

Reference books:

1. Introduction to Special Relativity : R. Resnick (Wiley-Eastern).
2. Spacetime Physics : E. Taylor and J. Wheeler (Freeman 1992).
3. Special Relativity: A.P. French (W W Norton).
4. Introducing Einstein's Relativity: Ray D'Inverno (Oxford 1992).
5. An introduction to Relativity: J.V.Narlikar (Cambridge Univ press)
6. Spacetime and Geometry: S. Carroll (Pearson 2018).
7. Classical Mechanics : H.Goldstein et al, (Prentice Hall/Narosa).
8. Introduction to Classical Mechanics (with problems and solutions): D.J. Morrin (Cambridge Univ Press, 2008).
9. Mechanics: L. D. Landau and E.M. Lifshitz (Elsevier)
10. Classical Mechanics : N. C. Rana and P.S. Joag (McGraw Hill, 2017).

M.SC. - Physics

(Semester I to IV)

Semester I	Semester II	Semester III			Semester IV		
Mathematical Physics (PHYC-101)	Mathematical Physics (PHYC-201)	Quantum Mechanics -2 (PHYC-301)			Quantum Mechanics-3 (PHYC-401)		
Classical Mechanics (PHYC-102)	Statistical Physics (PHYC-202)	Nuclear Physics-1 (PHYC-302)			Nuclear Physics-2 (PHYC-402)		
Electromagnetic Theory (PHYC-103)	Classical Electrodynamics (PHYC-203)	Solid State Physics-1 ((PHYC-303)			Solid State Physics (PHYC-403)		
Quantum Mechanics-I (PHYC-104)	Atomic & Molecular Spectra (PHYC-204)	Electronics (PHYC-304A)	Optoelectronic (PHYC-304B)	X-Rays (PHYC-304C)	Electronics (PHYC-404A)	Optoelectronics (PHYC-404B)	X-Rays (PHYC-404C)
Optics/Electronics Lab (PHYE-105)	Optics/Electronics Lab (PHYE-205)	Electronics Lab (PHYC-305A)	Optoelectronics Lab (PHYC-305B)	X-Ray Lab (PHYC-304C)	***Master Thesis*** (PHYC-405)		
		General Lab (PHYC-304)					
Instrumentation & Devices (PHYE-101)	Instrumentation & Devices (PHYE-201)	Material Synthesis & Characterization (PHYE-301)			Physics at LHC & Beyond (PHYE-401)		

Each paper carries 100 Marks (4 Credits)

17/05/19 17/5/19 17/5/19 17/5/19

Annexure VIII

Annexure V

M.Sc. (Physics) Semester I

PHYE-105

Introduction to electronic communication (4 Credits)

UNIT-I (12 Lectures)

Introduction to modern communication systems, Electromagnetic spectrum and allocations, bandwidth and information capacity. Time and frequency domains. Signal magnitudes and ranges, Decibel calculations, Noise and its effect.

UNIT-II (10 Lectures)

Need for modulation, Basics of amplitude modulation, transmitter functions ,receiver techniques.

Concept of frequency modulation, FM spectrum and bandwidth.

Comparison of AM and FM

UNIT-III (10 Lectures)

Digital information in communication, Sampling bandwidth and bit rates. Analog to digital and Digital to analog converter.

Introduction to the internet and world wide web.

UNIT-IV (10 Lectures)

Fiber-Optic system characteristics, The optical fiber, brief introduction of Sources and detectors for fiber optic communication, Complete systems and networks, Fiber optic testing.

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Inorganic Chemistry

Semester I **Paper – 1** **Max Marks: 100 (80 + 20)**

UNIT I

I. Atomic Structure: Quantum mechanics based structure of atom in brief, shapes of s, p and d orbitals, aufbau and Pauli exclusion principles, Hund's Multiplicity rules. Electronic configurations of the elements, effective nuclear charge.

II. Periodic Properties and Classification based upon electronic configuration: Diagonalrelationship, inert pair effect, atomic and ionic radii, van der waal radii, ionizationenergy,

III. Electron affinity and electronegativity : definition, method of determination, trends in periodic table and applications in predicting and explaining chemical behaviour.

UNIT II

IV. Chemical Bonding

(a) Covalent bond: valence bond theory and its limitations, directional characteristic of covalent bond. Hybridization and shapes of simple molecules and ions. Valence Shell Electron Pair Repulsion (VSEPR) theory to simple molecules and ions. Molecular Orbital theory for homonuclearand heteronuclear (CO and NO) diatomic molecules, multi-center bonding in electron deficient molecules, bond strength and the bond energy, % ionic character from dipole moment and electro
negativity difference.

(b) Weak interactions: hydrogen bonding, van der Waals forces.

UNIT III

V. Ionic solid: ionic structures, radius ratio effect and coordination number, limitation of ratio rule, Lattice defects, Lattice energy and Born-Haber cycle, solvation energy and solubility of ionic solids, polarizing power and polarizability of ions. Fajan's rule, Metallic bond free electron, Valence bond and Band theories.

VI. s-Block elements: Comparative study, salient features of hydrides, salvation and complexation tendencies of cations of alkali and alkaline earth matter including their function in biosystems, an introduction to alkyls and aryls of Li & Mg.

VII. Noble Gases: Chemical properties of the noble gases, discovery of $O_2^+PtF_6$Ė and O_2XeF_6.Chemistry of xenon, structure and bonding in xenon compounds.

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Inorganic Chemistry

Semester I **Paper – 1** **Max Marks: 100 (80 + 20)**

UNIT IV

VIII. p-Block Elements:- Comparative study (including diagonal relationship) physical and chemical behaviour of group 13-17 elements, compounds like hydrides, oxides, oxyacids and halides ofgroup 13-16, diborane, boronitride Ŭ, ɓ forms, Fullerenes, silicates(structural principle) andstructures of oxides and oxyacids of phosphorus and sulphur, interhalogens and polyhalides.

Text Books (Theory Courses):

(a) Concise Inorganic Chemistry, J.D. Lee, Blackwell Science Ltd.
(b) Inorganic Chemistry, Puri, Sharma, Kalia and Kaushal.
(c) Pradeep's Inorganic Chemistry, K.K. Bhasin, Pradeep Publication.
(d) Chemistry for degree students, R. L. Madan

Reference Books:

(a) Inorganic Chemistry, J.E.Huheey, Ellen A. Keiter, Richard L. Keiter, Addison Wesley Longman (Singapore) Pvt. Ltd.
(b) Inorganic Chemistry, D.E.Shriver, P W. Atkins and C.H.L. Langford, Oxford.
(c) Basic Inorganic Chemistry, F.A. Cotton, G. Wilkinson and P.L. Gaus, Wiley.
(d) Concepts of Models of Inorganic Chemistry, B.Douglas, D.McDaniel and J Alexander, John Wiley.
(e) Inorganic Chemistry, W.W. Porterfield, Addison - Wesley.
(f) Inorganic Chemistry, A.G. Sharpe, ELBS
(g) Inorganic Chemistry, G.L. Meissler and D.A. Tarr, Prentice-Hall.

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Organic Chemistry

Semester I **Paper – 2** **Max Marks: 100 (80 + 20)**

UNIT I

I. Structure and bonding: Hybridization, bond lengths, bond angles, bond energy, localised and delocalized ´ bonds, resonance, inductive and field effects, hydrogen bonding, inclusion compounds, clathrates, charge transfer complexes, van der Waals interaction, hyperconjugation, aromaticity.

II. Mechanism of Organic Reactions: Curved arrow notation, drawing electron movements with arrows, half headed and double-headed arrows, homolytic and heterolytic bond breaking Reactive intermediates-generation, structure, stability and reactions of carbocation, carbanion, free radicals and carbenes, Arynes, Nitrenes.

III. Types of organic reactions-addition, elimination, substitution, rearrangement, condensation, methods of determination of reaction mechanism (product analysis, intermediates, isotopic effects, kinetic and stereochemical studies). Energy considerations.

UNIT II

IV. Stereoisomerism

Optical isomerism: Elements of symmetry, molecular chirality, optical activity, stereogenic centres, enantiomers, properties of enantiomers, chiral and achiral molecules with two stereogenic centres, diastereomers, threo and erythro diastereomers, meso compounds, resolution of enantiomers, inversion, retention and racemization. Relative and absolute configurations. Sequence rules. D, L and R, S nomenclature.

Geometrical isomerism: determination of configuration of geometric isomers. E, Z system, geometrical isomerism in oximes and alicyclic compounds. Conformatioal isomerism-Conformational analysis of ethane and n-butane and cyclohexane, axial and equatorial bonds, Saw-horse and flying wedge formulae, Fischer and Newman projections formulae. Difference between conformation and configuration.

UNIT – III

V. Alkanes And Cycloalkanes: Methods of formation with special reference to Wurtz, Kolbe, Corey-House reactions and decarboxylation. Physical properties and chemical reactions. Mechanism of free radical halogenation of alkanes: orientation, reactivity and selectivity.

Cycloalkanes: Nomenclature, methods of preparation. Baeyer's strain theory and its limitations. Ring strain in (cyclopropane and cyclobutane), theory of strainless rings. The case of cyclopropane ring and banana bond.

VI. Alkenes, Cycloalkenes, Dienes: methods of formation. Mechanisms of dehydration of alcohols and dehydrohalogenation of alkyl halides. Regio-selectivity in alcohol-dehydration. Saytzeff's rule, Hofmann elimination.

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Organic Chemistry

Semester I **Paper – 2** **Max Marks: 100 (80 + 20)**

Physical properties and relative stabilities of alkenes. Chemical reactions of alkenes- Mechanisms involved in hydrogenation, electrophilic and free-radical additions. Markownikoffûs rule. Hydroboration-oxidation, oxymercuration-reduction, epoxidation, ozonolysis, hydrations, hydroxylation and oxidation with $KMnO_4$, polymerization of alkenes. Substitutions at allylic and vinylic positions of alkenes.

Methods of formation, conformation and chemical resections of cycloalkenes.

Nomenclature and classification of dienes: isolated, conjugated and cumulated dienes, Structure of allenes and butadiene, methods of formation, chemical reaction ï 1, 2 and 1, 4 additions, Diels-Alder reaction.

VII. Alkynes: Structure and bonding in alkynes. Methods of formation, chemical reactions and acidity of alkynes. Mechanism of electrophilic and mucleophilic addition reactions, hydroboration-oxidation, reductions and oxidation reactions.

UNIT IV

VIII. Arenes and Aromaticity: Nomenclature of benzene derivatives. Structure of benzene: molecular formula and Kekule structure. Stability and carbon carbon bond length of benzene, resonance structure, MO picture.

IX. Aromatic electrophilic substitution- general pattern of the mechanism, Arrhenium ion intermediate. Mechanism of nitration, halogenation, sulfonation, mercuration and Friedel-Crafts reaction. Energy profile diagrams. Activation and deactivating substituents, orientation and ortho/para ratio. Side chain reactions of benzene derivatives. Birch reduction.

X. Alkyl and Aryl Halides: Methods of formation, chemical reactions. Mechanism of nucleophilic substitution reactions of alkyl halides, SN2 and SN1 reactions with energy profile diagrams, chloroform. Aryl halides - Methods of formation, nuclear and side chain reactions. Mechanisms of nucleophilic aromatic substitutions. Synthesis and uses of DDT, BHC.

Text Books (Theory Courses):

a. Organic Chemistry, Vol. I, I.L. Finar, Pearson Education.
b. Organic Chemistry, M.K. Jain, Shoban Lal& Co.
c. Pradeep's Organic Chemistry, S.N. Dhawan, Pradeep Publication.

Reference Books:

a. Organic Chemistry, Morrison and Boyd, Prentice Hall.
b. Organic Chemistry, L.G. Wade Jr. Prentice Hall.
c. Fundamentals of Organic Chemistry Solomons, John Wiley.
d. Organic Chemistry, Vol. I, II, III S.M. Mukherji, S.P. Singh and R.P. Kapoor, Wiley Eastern Ltd. (New Age International)
e. Organic Chemistry, F.A. Carey, McGraw-Hill Inc.
f. Introduction to Organic Chemistry, Streitwiesser, Hathcock and Kosover, Macmillan.

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Physical Chemistry

Semester II **Paper 3** **Max Marks: 100 (80 + 20)**

UNIT I

I. Mathematical Concepts: Logarithmic relations, curves scratching, equation of straight line and slopes, tracing of curves, differentiation of simple functions like x, ex, xn, sinx, logx; maxima and minima, partial differentiation. Integration of some useful/relevant functions; Permutations and Combinations. Factorials, Probability.

II. Computers: General introduction to computers, different components of a computer. Hardware and Software, input-output devices, binary numbers and its arithmetic; introduction to computer languages, Programming and operating systems.

UNIT II

III. Gaseous State: Deviation of gases from ideal behaviour, van der Waals equation of State.

IV. Critical phenomenon: PV isotherms of real gases, continuity of states, the isotherms of van der Waals equations, relationship between critical constants and van der Waals constants, the law of corresponding states, reduced equation of states.

V. Molecular Velocities: Qualitative discussion of the Maxwell's distribution of molecular velocities, collision numbers, mean free path and collision diameter. Liquification of gases (based on Joule Thomson effect).

VI. Liquid State: A qualitative description of intermolecular forces, structure of liquids,structural differences between solids, liquids and gases.

VII. Liquid crystals: Difference between liquid crystal, solid and liquid. Classification, structure of nematic, smectic and cholestric liquid crystals. Thermography and seven segment cell.

UNIT III

VIII. Solid State: Definition of unit cell and space lattice.

IX. Laws of crystallography:

a. Law of constancy of interfacial angles

b. Law of rationality of indices

c. Symmetry elements in crystals and law of symmetry.

X. Diffraction-X-ray diffraction by crystals. Derivation of Bragg's equation. Laueôs method and powder method, determination of crystal structure of NaCl, KCl and CsCl

XI. Colloidal State: Solids in liquids (sols): properties- Kinetic, optical and electrical; stability of colloids, protective action, Hardy-Schulz law, gold number.

XII. Liquids in liquids (emulsions): types of emulsions, preparation. Emulsifier.

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Physical Chemistry

Semester II **Paper 3** **Max Marks: 100 (80 + 20)**

XIII. Liquids in solids (gels): classification, preparation and properties, inhibition, general applications of colloids.

UNIT IV

XIV. Chemical Kinetics:

a. Molecularity and order of reaction, concentration dependence of rates, integrated rate expression for- zero order, first order, second order, pseudo order reactions, half-life.

b. Determination of the order of reaction: Differential method, method of integration, half-life method and isolation method.

c. Brief outlines of experimental methods of studying chemical kinetics: conductometric, potentiometric, optical methods, polarimetry and spectrophotometery.

d. Theories of chemical kinetics: Arrhenius theory of reaction rate, effect of temperature on rate of reaction, concept of activation energy. Simple collision theory based on hard sphere model, transition state theory (equilibrium hypothesis).Thermodynamics aspect of transition state theory.

XV. Catalysis: Catalysis, classification of catalysis, characteristics of catalysed reactions,

Text Books (Theory Courses):

a. Physical Chemistry, Puri Sharma & Pathania.
b. Pradeep Physical Chemistry, Khetrapal, Pradeep Publication.
c. Computers and Common Sense, R. Hunt and Shelly, Prentice Hall.

Reference Books:

a. Physical Chemistry. G.M. Barrow. International Student Edition, McGrawHill
b. Physical Chemistry, R.A. Alberty, Wiley Eastern Ltd.
c. The Elements of Physical Chemistry, P.W. Atkins, Oxford.
d. Physical Chemistry Through problems, S.K. Dogra and S. Dogra, Wiley Eastern Ltd.
e. Basic Programming with Application, V.K. Jain, Tata McGraw Hill.
f. Physical Chemistry, Glasstone

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Chemistry

Semester II **Practical** **Max Marks: 100**

Inorganic

I. Qualitative Analyses:

a. Identification of cations and anions in a mixture of inorganic compounds soluble in water/dilute acids (Macro/semi-micro analysis- cation analysis, separation of ions from group 0-VI, anion analysis). Only six radicals.

II. Quantitative Analysis:

a. *Volumetric Analysis*

i. Determination of acetic acid in commercial vinegar using NaOH

ii. Determination of alkali content - antacid tablet using HCl.

iii. Estimation of calcium content in chalk as calcium oxalate by permanganometry

iv. Estimation of hardness of water by EDTA

v. Estimation of ferrous ions by dichromate method

vi. Estimation of copper using thiosulphate.

b. *Gravimetric Analysis*

i. Ba as $BaSO_4$ in the given solution of $BaCl_2$

ii. Analysis of Cu as CuSCN

iii. Analysis of Ni as $Ni(DMG)_2$

Record & Viva

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Physical Chemistry

Semester III **Paper 4** **Max Marks: 100 (80 + 20)**

UNIT I

I. Thermodynamics-1

a. Definition of thermodynamic terms: System, surroundings etc. Types of systems, intensive andextensive properties. State and path functions and their differentials. Thermodynamic process. Concept of heat and work.

b. First Law of Thermodynamics: Statement, definition of internal energy and enthalpy. Heat capacity, heat capacities at constant volume and pressure and their relationship. Joule's law - Joule-Thomson coefficient and inversion temperature. Calculation of w,q, dU&dH for the expansion of ideal gases under isothermal and adiabatic conditions for reversible process.

II. Thermochemistry: Standard state, standard enthalpy of formation - Hess's Law of heat summation and its applications. Heat of reaction at constant pressure and at constant volume. Enthalpy of neutralization. Bond dissociation energy,effect of temperature on enthalpy of reaction, Kirchhoff s equation.

UNIT II

III. Thermodynamics - II

a. Second law of thermodynamics: statements of second law of thermodynamics, Carnot's cycle and its efficiency, Carnot's theorem. Thermodynamic scale of temperature, Le Chatelierôs principle, reaction isotherm and reaction isochore, Clapeyron-Clausius equation and its applications

b. Concept of entropy: Entropy as a state function, entropy as a function of V & T, entropy as a function of P & T, entropy change in physical change, criteria of spontaneity and equilibrium change in ideal gases and mixing of gases.

IV. Gibbs and Helmholtz free energy functions and their definitions

UNIT III

V. Electrochemistry -1:

a. Electrical transport - Conduction in metals and in electrolyte solutions, specific conductance, equivalent conductance, experimental determination of equivalent conductance and specific conductance, variation of equivalent and specific conductance with dilution. Kohlrausch's law, weak and strong electrolyte, Arrhenius theory of electrolyte dissociation and its limitations. Ostwald's dilution law its uses and limitations. Debye-Huckel-Onsager's equation for strong electrolytes (elementary treatment only). Transport number, definition and its determination by Hittorfs method and moving boundary method.

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Physical Chemistry

Semester III **Paper 4** **Max Marks: 100 (80 + 20)**

VI. Applications of conductivity measurements: Determination of degree of dissociation, determination of Ka of acids, determination of solubility product of a sparingly soluble salt, conductometric titrations.

UNIT IV

VII. Electrochemistry - II:

a. Types of reversible electrodes- Gas-metal ion, metal-ion, metal-insoluble salt-anion and redox electrodes. Electrode reactions, single electrode potential, standard electrode potential. Reference electrode: standard hydrogen electrode and calomel electrode, Nernst equation, derivation of cell E.M.F., electrochemical series and its significance.

b. Electrolytic and Galvanic cells- Reversible and irreversible cells, conventional representation of electrochemical cells.

c. EMF of a cell and its measurements- Calculation of cell EMF. Calculation of thermodynamic quantities of cell reactions (ΔG, ΔH and K)

d. Concentration cell with and without transport, liquid junction potential, application of concentration cells, valency of ions, solubility product and activity coefficient, potentiometric titrations.

VIII. Definition of pH and pKa, determination of pH using quinhydrone and glass electrodes by potentiometric methods. Buffers - Mechanism of buffer action, Henderson-Hazel equation. Hydrolysis of salts.

Books Suggested (Theory Courses)

a. Physical Chemistry. G.M. Barrow. International Student Edition, McGraw Hill.
b. Physical Chemistry, R.A. Alberty, Wiley Eastern Ltd.
c. The Elements of Physical Chemistry, P.W. Atkins, Oxford.
d. Physical Chemistry Through problems, S.K. Dogra and S. Dogra, Wiley Eastern Ltd.
e. Graduate physical Chemistry,VolumeI-III By L.R.sharma and M.s..Pathania
f. Principles of Physical Chemistry by B.R.Puri,L.P Sharma and M.S.Pathania,V ishal publication ,Jallandhar.

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Chemistry

Semester III **Practical** **Max Marks: 100**

Physical Chemistry

1. Chemical Kinetics
    a. To determine the specific reaction rate of the hydrolysis of methyl acetate/ethyl acetate catalyzed by hydrogen ions at room temperature.
2. Distribution Law
    a. To study the distribution of iodine between water and CCI4.
3. Colloids
    a. To prepare arsenious sulphide sol and compare the precipitating power of mono-, bi- and trivalent anions.
4. Viscosity, Surface Tension
    a. To determine the percentage composition of a given binary mixture (non interacting systems) by viscosity method.
    b. To determine the percentage composition of a given binary mixture (non interacting systems) by surface tension method (acetone & ethyl methyl ketone).
5. Phase Equilibrium
    a. To construct the phase diagram of two component (e.g. diphenylamine benzophenone) system by cooling curve method.
6. Thermochemistry
    a. To determine the solubility of benzoic acid at different temperatures and to determine æH of the dissolution process.
    b. To determine the enthalpy of neutralisation of a week acid/weak base versus strong base/strong acid and determine the enthalpy of ionisation of the weak acid/weak base.

Organic Chemistry

a. Sublimation
b. Crystallization
c. Identification of organic compounds with derivatives (solid compounds of all functional groups and liquid compounds.

Record and Viva

Books Recommended

(a) Chemistry Practical by S.Giri, D.N. Bajpai and O.P.Shukla,S.Chand Publication.
(b) Practical Chemistry Volume 1-3 by Fateh Bahadur, Vishal Publication
(c) Advanced Physical Chemistry by J.B.Yadav, Goel Publication

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Inorganic Chemistry

Semester IV **Paper 5** **Max Marks: 100 (80 + 20)**

UNIT I

I. Chemistry of Elements of First Transition Series: Characteristic properties of d-block elements. Binary compounds (hydrides, carbides and oxides) of the elements of the first transition series and complexes with respect to relative stability of their oxidation states, coordination number and geometry.

II. Chemistry of Elements of Second and Third Transition series: General characteristics, comparative treatment of Zr/Hf, Nb/Ta , Mo/W in respect of ionic radii, oxidation states, magnetic behavior, spectral properties and stereochemistry.

Unit - II

III. Coordination Compounds and double salts: Werner's coordination theory and its experimental verification, Sidgwickôs concept of effective atomic number, EAN concept, Polydentate ligands or chelates, nomenclature of coordination compounds, isomerism in coordination compounds, valence bond theory of transition metal complexes, Inner and outer orbital complexes, Limitations of VBT.

UNIT III

IV. Chemistry of Lanthanide Elements: Electronic structure, oxidation states and ionic radii and lanthanide contraction, complex formation, occurrence and isolation, cerie ammonium sulphate and its analytical uses.

V. Chemistry of Actinides: Electronic conformation, oxidation states and magnetic properties, chemistry of separation of Np, Pu and Am from U.

Unit IV

VI. Oxidation and Reduction: Electrode potential, electrochemical series and its applications. Principles involved in the extraction of the elements.

VII. Acids and Bases : Arrhenius, Bronsted-Lowry, the Lux-Flood, solvent system and Lewis concept of acids and bases.

VIII. Non-aqueous Solvents: Physical properties of a solvent, types of solvents and their generalcharacteristics, Reactions in non-aqueous solvents with reference to liquid NH_3 and liquid SO_2.

Text Books (Theory Courses):

a. Concise Inorganic Chemistry, J.D. Lee, Blackwell Science Ltd.
b. Inorganic Chemistry, Puri, Sharma, Kalia and Kaushal.
c. Pradeep's Inorganic Chemistry, K.K. Bhasin, Pradeep Publication.
d. Chemistry for degree students, R. L. Madan

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Inorganic Chemistry

Semester IV **Paper 5** **Max Marks: 100 (80 + 20)**

Reference Books:

a. Inorganic Chemistry, J.E.Huheey, Ellen A. Keiter, Richard L. Keiter, Addison Wesley Longman (Singapore) Pvt. Ltd.
b. Inorganic Chemistry, D.E.Shriver, P W. Atkins and C.H.L. Langford, Oxford.
c. Basic Inorganic Chemistry, F.A. Cotton, G. Wilkinson and P.L. Gaus, Wiley.
d. Concepts of Models of Inorganic Chemistry, B.Douglas, D.McDaniel and J Alexander, John Wiley.
e. Inorganic Chemistry, W.W. Porterfield, Addison - Wesley.
f. Inorganic Chemistry, A.G. Sharpe, ELBS
g. Inorganic Chemistry, G.L. Meissler and D.A. Tarr, Prentice-Hall.

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Organic Chemistry

Semester IV **Paper 6** **Max Marks: 100 (80 + 20)**

UNIT I

I. Alcohols:

Monohydric alcohols - Methods of formation by reduction of aldehydes, Ketones, Carboxylic acids and Esters, Hydrogen bonding, Acidic nature,Reactions of alcohols.

Dihydric alcohols - Nomenclature, methods of formation, chemical reactions of vicinal glycols, oxidative cleavage [$Pb(OAc)_4$ and HIO_4] and pinacole-pinacolone rearrangement.

Trihydric alcohols - Nomenclature and methods of formation, chemical reactions of glycerol.

II. Ethers and Epoxides: Nomenclature of ethers and methods of their formation, physical properties, Chemical reactions - cleavage and autoxidation, Ziesel's method. Synthesis of epoxides, Acid and base-catalyzed ring opening of epoxides, orientation of epoxide ring opening by Grignard and organolithium reagents.

UNIT II

III. Phenols:- Preparation of phenols, physical properties and acidic character. Comparative acidic strengths of alcohols and phenols, resonance stabilization of phenoxide ion. Reactions of phenols - electrophilic aromatic substitution, acylation and carboxylation. Mechanisms of Fries rearrangement, Claisen rearrangement, Gatterman synthesis, Hauben-Hoesch reaction, Lederer-Manasse reaction and Reimer-Tiemann reaction.

IV. Aldehydes and Ketones: synthesis of aldehydes and ketones with particular reference to the synthesis of aldehydes from acid chlorides, synthesis of aldedydes and ketones using 1,3-dithianes, synthesis of ketones from nitrites and from carboxylic acids. Physical properties. Mechanism of nucleophillic additions to carbonyl group with particular emphasis on benzoin, aldol, Perkin and Knoevenagel condensations, Condensation with ammonia and its derivatives. Wittig reaction, Mannich reaction. Use of acetals as protecting group, Oxidation of aldehydes, Baeyer-Viliiger oxidation of Ketones, Cannizzaro reaction, MPV, Clemmensen, Wolff-Kishner, $LiAlH_4$ and NaBH4 reductions. Halogenation of enolizable ketones. An introduction to Ŭ,ƀ-unsaturated aldehydes and ketones.

UNIT III

V. Carboxylic Acids: physical properties, acidity of carboxylic acids, effects of substituents on acid strength. Preparation of carboxylic acids, Reactions of carboxylic acids, Hell-Volhard-Zelinsky reaction, Synthesis of acid chlorides, esters and amides. Reduction of carboxylic acids, Mechanism of decarboxylation. Methods of formation and chemical reactions of halo acids,

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Organic Chemistry

Semester IV **Paper 6** **Max Marks: 100 (80 + 20)**

VI. Hydroxy acids: Preparation and reactions. Methods of formation and chemical reactions of unsaturated monocarboxylic acids. Dicarboxylic acids: Methods of formation and effect of heat and dehydrating agents.

VII. Carboxylic Acid Derivatives: Structure and nomenclature of acid chlorides, esters, amides (urea) and acid anhydrides. Relative stability of acyl derivatives. Physical properties, interconversion of acid derivatives by nucleophilic acyl substitution. Preparation of carboxylic acid derivatives, chemical reactions. Mechanisms of esterification and hydrolysis (acidic and basic).

UNIT IV

VIII. Organic Compounds of Nitrogen: Preparation of nitroalkanes and nitroarenes. Chemical reactions of nitroalkanes. Mechanisms of nucleophilic substitution in nitroarenes and their reductions in acidic, neutral and alkaline media.

IX. Amines: Preparation, physical properties, stereochemistry of amines. Separation of a mixture of primary, secondary and tertiary amines. Structural features effecting basicity of amines. Amine salts as phase-transfer catalysts. Preparation of alkyl and aryl amines (reduction of nitro compounds, nitriles), reductive amination of aldehydicand ketonic compounds. Gabriel -phthalimide reaction, Hoffmann bromamide reaction. Reactions of amines, electrophilic aromatic substitution in aryl amines, reactions of amines with nitrous acid. Synthetic transformations of aryl diazonium salts, azo coupling.

Books Suggested (Theory Courses)

a. Organic Chemistry, Morrison and Boyd, Prentice Hall.
b. Organic Chemistry, L.G. Wade Jr. Prentice Hall
c. Fundamentals of Organic Chemistry Solomons, John Wiley.
d. Organic Chemistry, Vol. I, II, III, S.M. Mukherji, S.P. Singh and R.P. Kapoor, Wiley Eastern Ltd. (New Age International).
e. Organic Chemistry, F.A. Carey, McGraw-Hill Inc.
f. Introduction to Organic Chemistry, Streitwiesser, Hathcock and Kosover, Macmillan.
g. Organic Chemistry, Vol. I, II, I.L. Finar
h. Spectrometric Identification of organic compounds. Robert M. Silverstein, Clayton G. Bassler, Terence C. Morril, John Wiley.

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Organic Chemistry

Semester V **Paper 7** **Max Marks: 100 (80 + 20)**

UNIT I

I. Organometallic Compounds: Organomagnesium compounds: the Grignard reagents, formation, structure and chemical reactions. Organozinc compounds; formation and chemical reactions. Organolithium compound formation and chemical reactions.

II. Organosulphur compounds: Nomenclature, structural, features, methods of formation and chemical reactions of thiols, thioethers, sulphonic acids, sulphonamides and sulphaguanidene.

III. Heterocyclic compounds

Introduction: Molecular orbital picture and aromatic characteristic of pyrrole, furan, thiophene and pyridine, methods of synthesis and chemical reactions with particular emphasis on the mechanism of electrophilic substitution, mechanism of nucleophilic substitution reaction in pyridine derivatives. Comparison of basicity of pyridine, piperidine and pyrrole.Introduction to condensed five and six membered heterocycles. Preparation and reactions of indols, quinoline and isoquinoline with special reference to Fisher Indols synthesis, Skraup synthesis and Bischler ï Nepieralski synthesis. Mechanism of electrophilic substitution reaction of indole, quinoline and isoquinoline.

UNIT II

IV. Carbohydrates: Classification and nomenclature, configuration and conformation of monosaccharides, Erythro and threo diastereomers, mechanism of osazone formation, interconversion of glucose and fructose, chain lengthening and chain shortening of aldoses. Formation of glycoside, ethers and esters. Determination of ring size of monosaccharides. Cyclic structure of D(+) glucose. Mechanism of mutarotation, structure of ribose and deoxyribose. An introduction to disaccharides (maltose, sucrose, lactose) and polysaccharide/starch and cellulose) without involving structure determination.

UNIT III

V. Amino Acids, peptides, proteins and Nucleic Acids: Classification, structure and stereochemistry of amino acids. Acid-base behaviour, isoelectric point and electrophoresis, Preparation and reaction of a amino acids, structure and nomenclature of peptides and proteins. Classification of proteins, peptides structure determination, and group analysis. Selective hydrolysis of peptides. Classical peptide synthesis, solid phase peptide synthesis. Structure of peptides and proteins level of protein structures. Protein denaturation/renaturation.

Nucleic Acids: Introduction - Classification of nucleic acids Ribonueleosides and Ribonucleotides. The double helical structure of DNA.

VI. Fats, Oils and Detergents: Natural fats, edible and industrial oils of vegetable origin, common fatty acids, glycerides, hydrogenation of

Organic Chemistry

Semester V **Paper 7** **Max Marks: 100 (80 + 20)**

unsaturated oils, saponification value, iodine value, acid value, soaps, synthetic detergents alkyl and aryl sulphonates.

UNIT IV

VII. Synthetic Polymers: Addition or chain-growth polymerization, Free radical vinyl polymerization, ionic vinyl polymerization, Ziegler-Natta polymerization and vinyl polymers. Condensation or step growth polymerization. Polyesters, polyamides, phenol formaldehyde resins, urea formaldehyde resin, epoxy resins and poly urithanes. Natural and synthetic rubbers.

VIII. Synthetic Dyes: Colour and constitution / electronic concept classification of dyes. Chemistry and synthesis of Methyl orange, conge red, Malachite green, crystal violet, phenophthalein, Fluorescin, Alizarin and Indigo.

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Physical Chemistry

Semester V **Paper 8** **Max Marks: 100 (80 + 20)**

UNIT I

I. Introductory Quantum Mechanics, Physical properties and Molecular Structure: Introductory Quantum Mechanics: Black-body radiation, Plank's radiation law, photoelectric effect, Compton effect.

II. Physical Properties and Molecular Structure: Optical activity, polarization (clausius-Mossotti equation), orientation of dipoles in an electric field, dipole moment, induced dipole moment, measurement of dipole moment, temperature method and refractivity method, dipole moment and structures of molecules, magnetic properties ï paramagnetism, diamagnetism and ferromagnetism.

UNIT II

III. Photochemistry

a. Interaction of radiation with matter, difference between thermal and photochemical processes.

b. Laws of photochemistry: Grothus-Drapper law, Stark-Einstein law, Jablonski diagram depicting various processes occurring in the excited state, qualitative description of fluorescence, phosphorescence, non-radiative processes (internal conversion, intersystem crossing), quantum yield, photosensitized reactions-energy transfer processes (simple examples).

UNIT III

IV. Solutions, Dilute Solutions and Colligative Properties : Ideal and non-ideal solutions, methods of expressing concentration of solutions, activity and activity coefficient, Dilute solution, colligative properties, Raoult's law, relative lowering of vapour pressure, molecular weight determination, Osmosis, theory of osmotic pressure and its measurement, determination of molecular weight from osmotic pressure, Elevation of boiling point and depression of freezing point. Thermodynamic derivation of relation between molecular weight and elevation in boiling point and depression in freezing point. Experimental methods of determining various colligative properties. Abnormal molar mass, degree of dissociation and association of solutes.

UNIT IV

V. Third law of thermodynamics, Nernst heat theorem, statement and concept of residual entropy. Thermodynamic derivation of Nernst distribution law and its application. Phase rule and its derivation. Application of Gibbs phase rule for one component system- water and sulphur system, two component system- Bi-Cd, Pb-Ag, desilverization of lead.

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Physical Chemistry

Semester V **Paper 8** **Max Marks: 100 (80 + 20)**

Books suggested (Theory Courses)

a. Physical Chemistry, G.M. Barrow, International Student Edition, McGraw Hill.
b. Physical Chemistry, R.A. Alberty, Wiley Eastern Ltd.
c. The Elements of Physical Chemistry, P.W. Atkins, Oxford.
d. Physical Chemistry through Problems, S.K. Dogra and S. Dogra Wiley Eastern Ltd.

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Chemistry

Semester V **Practical** **Max Marks: 100**

A: Inorganic Chemistry

I. Synthesis and Analysis

a. Preparation of potassium trioxalatoferrate (III), $K_3[Fe(C_2O_4)_3]$ and determination of itscomposition by permagnometry.
b. Preparation of Ni-DMG complex, $[Ni(DMG)_2]$
c. Preparation of copper tetraammine complex, $[Cu(NH_3)_4]SO_4$
d. Preparation of cis-and trans-bisoxalatodiaqua chromate (III) ion.

II. Colorimetry

a. To verify Beer-Lambert law for $KMnO_4/K_2Cr_2O_7$ and determine the concentration of the given solution.
b. Determination of Fe^{3+} content by thiocyanate method.

III. Solvent Extraction

a. Separation and estimation of Mg(II) and Fe(II) Ion Exchange Method
b. Separation and estimation of Mg(II) and Zn(II).

IV. Chromatography

a. Chromatographic separation of metal ions.

B: Organic Chemistry

I. Mixture Analysis

a. Organic mixture separation and identification (two components)

II. Preparation

b. One step preparation.

C: Physical Chemistry

I. Electrochemistry

a. To determine the strength of the given acid conductometrically using standard alkali solution.
b. To determine the solubility and solubility product of a sparingly soluble electrolyte conductometrically.
c. To determine the ionisation constant of a weak acid conductometrically.

II. Refractometry and Polarimetry

a. To verify law of refraction of mixtures (e.g. of glycerol and water) using Abbeôs refractometer.
b. To determine the specific rotation of cane sugar solution by polarimeter.

III. Molecular Weight Determination

a. Determination of molecular weight of a non-volatile solute by Rast method/Beckmann freezing point method.
b. Determination of the apparent molecular weight of non volatile solute at different concentration and determine Vanôt Hoff factor by ebullioscopy.

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Chemistry

Semester V **Practical** **Max Marks: 100**

IV. Colorimetry

a. To verify Beer-Lambert law for $KMnO_4/K_2Cr_2O_7$ and determine the concentration of the given solution of the substance.

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Inorganic Chemistry

Semester VI **Paper 9** **Max Marks: 100 (80 + 20)**

Unit - I

I. Metal-ligand bonding in Transition Metal Complexes: Limitation of valence bond theory, an elementary idea of crystal field theory, crystal field splitting in octahedral, tetrahedral and square planar complexes, factors effecting the crystal field parameters. Effect of CFSE on lattice energy, Ionic radii.

Unit - II

II. Magnetic Properties of Transition Metal Complexes: Types of magnetic behaviour, methods of determining magnetic susceptibility, spin only formula, L-S coupling, Spectroscopic ground state, Correlation of ε_S and ε_{eff} values. Orbital contribution to magnetic moments. Application of magnetic moment data for 3d metal complexes.

Unit - III

III. Silicones and phosphazenes as examples of inorganic polymers. Nature of bonding in triphosphazenes. Pseudohalogens and pseudohalides: Preparation, properties and reactions. Structure and bonding of NO, ligand behaviour of NO. Preparation of nitrosyl complexes, effective atomic number (EAN) as applied to nitrosyls.

Unit - IV

IV. Hard and Soft Acids and bases (HSAB) : Classification of acids and bases as hard and soft. Pearson's HSAB concept, acid base strength and hardness and softness. Symbiosis, theoretical basis of hardness and softness. Applications of HSAB principle, limitations of HSAB principle.

Text Books (Theory Courses):

a. Concise Inorganic Chemistry, J.D. Lee, Blackwell Science Ltd.
b. Inorganic Chemistry, Puri, Sharma, Kalia and Kaushal.
c. Pradeep's Inorganic Chemistry, K.K. Bhasin, Pradeep Publication.
d. Chemistry for degree students, R. L. Madan

Reference Books:

a. Inorganic Chemistry, J.E.Huheey, Ellen A. Keiter, Richard L. Keiter, Addison Wesley Longman (Singapore) Pvt. Ltd.
b. Inorganic Chemistry, D.E.Shriver, P W. Atkins and C.H.L. Langford, Oxford.
c. Basic Inorganic Chemistry, F.A. Cotton, G. Wilkinson and P.L. Gaus, Wiley.
d. Concepts of Models of Inorganic Chemistry, B.Douglas, D.McDaniel and J Alexander, John Wiley.
e. Inorganic Chemistry, WW. Porterfield, Addison - Wesley.
f. Inorganic Chemistry, A.G. Sharpe, ELBS
g. Inorganic Chemistry, G.L. Meissler and D.A. Tarr, Prentice-Hall.

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Inorganic Chemistry

Semester VI **Paper 10** **Max Marks: 100 (80 + 20)**

Unit – I

I. Thermodynamic and Kinetic Aspects of Metal Complexes: A brief outline of thermodynamic stability of metal complexes and factors affecting the stability. Substitution reaction of square planar complexes. Trans effect.

Unit - II

II. Electronic spectra of Transition Metal Complexes:

Types of electronic transitions, selection rules for d-d transitions, spectroscopic ground states, spectrochemical series, Orgel-energy level diagram for d^1 and d^9 states, discussion of the electronic spectrum of $[Ti(H_2O)_6]^{3+}$ complex ion.

Unit - III

III. Organometallic Chemistry: Definition, types of organometallic compound and their general methods of preparation of alkyls and aryls of Li, Hg and Sn. Applications of organometallic compounds. Metal carbonyls. 18 electron rule, preparation, structure and nature of bonding in carbonyls.

Unit - IV

IV. Bioinorganic Chemistry: Introduction, metalloenzyme/carboxypeptidase, carboxy-anhydrase. Metalloporphyrens with special reference to haemoglobin and myoglobin (structure, cooperative effect, Bohr's effect). Inorganic complexes in cancer treatment, anti-arthritis drugs, chelation therapy, imaging agents.

Text Books (Theory Courses):

a. Concise Inorganic Chemistry, J.D. Lee, Blackwell Science Ltd.
b. Inorganic Chemistry, Puri, Sharma, Kalia and Kaushal.
c. Pradeep's Inorganic Chemistry, K.K. Bhasin, Pradeep Publication.
d. Chemistry for degree students, R. L. Madan

Reference Books:

a. Inorganic Chemistry, J.E.Huheey, Ellen A. Keiter, Richard L. Keiter, Addison Wesley Longman (Singapore) Pvt. Ltd.
b. Inorganic Chemistry, D.E.Shriver, P W. Atkins and C.H.L. Langford, Oxford.
c. Basic Inorganic Chemistry, F.A. Cotton, G. Wilkinson and P.L. Gaus, Wiley.
d. Concepts of Models of Inorganic Chemistry, B.Douglas, D.McDaniel and J Alexander, John Wiley.
e. Inorganic Chemistry, W.W. Porterfield, Addison - Wesley.
f. Inorganic Chemistry, A.G. Sharpe, ELBS
g. Inorganic Chemistry, G.L. Meissler and D.A. Tarr, Prentice-Hall.
h. Bioinorganic Chemistry, K.H. Reddy, New Age

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Organic & Physical Chemistry

Semester VI **Paper 11** **Max Marks: 100 (80 + 20)**

UNIT I

I. Spectroscopy:

a. Rotational Spectroscopy of Diatomic Molecules: Energy level of a rigid rotor (semi classical principles) selection rules, spectral intensity, distribution using population distribution (Maxwell ï Boltzman distribution) determination of bond length, isotope effect.

b. Vibrational Spectrum-Infrared Spectrum: Energy levels of simple harmonic oscillator, selection rules, pure vibrational spectrum, intensity, determination of force constant and qualitative relation of force constant and bond energies, effect of an harmonic motion and isotope on the spectrum.

c. Raman Spectrum: Concept of polarizability, pure rotational and pure vibrational Raman spectra of diatomic molecules, selection rules.

UNIT II

II. Elementary Quantum Mechanics: de Broglie's hypothesis, the Heisenberg's uncertainty principle, Hamiltonian operator. Statement of Born-oppenheimer approximation. Schrodinger wave equation and its importance. Physical interpretation of wave function, postulates of quantum mechanics, particle in one dimensional box. Schrodinger wave equation for H ï atom and its separations into three equations (without derivation), quantum numbers, wave function, angular wave functions.

III. Basic idea of molecular orbital theory, criteria for forming M.Oûs from A.Oûs, construction of M.O's by LCAO-H^{2+} ion, calculation of energy levels from wave functions, physical picture of bonding and antiboding wave functions, Hybrid Orbitals-sp, sp^2, sp^3, calculation of coefficients of A.O's used in sp and sp^2 hybrid orbital only. Introduction to valence bond model of H_2, comparison of M.O. and V.B. models.

UNIT III

I. Electromagnetic Spectrum Absorption Spectra:

a. Ultraviolet (UV) absorption spectroscopy -absorption laws (Beer-Lambert law); molar absorptivity, presentation and analysis of UV spectra, types of electronic transitions, effect of conjugation. Concept of chromophore and Auxochrome, Bathochromic, hypsochromic, hyperchromic and hypochromic shifts. U.V.spectra of conjugated enes and enones, woodward fieser rule

b. Infrared (I.R.) absorption spectroscopy- Molecular vibrations, Hook's law, Selection rules, intensity and position of I.R. bands, fingerprint region, characteristic absorptions of various functional groups and interpretation of I.R. spectra of simple organic

Organic & Physical Chemistry

Semester VI **Paper 11** **Max Marks: 100 (80 + 20)**

compounds-hydrocarbons, aldehydes & ketones in IR spectrum (positions only)

UNIT IV

II. Spectroscopy: Nuclear magnetic resonance (NMR): Spectroscopy, proton magnetic resonance (1H NMR) spectroscopy, nuclear shielding and deshielding. Chemical shifts and molecular structure, spin-spin splitting and coupling constants, areas of signals, interpretation of 'H NMR spectra of simple organic molecules such as ethyl bromide, ethanol, acetaldehyde, 1, 1, 2 tribromoethane, ethyl acetate, toluene and acetophenones. Problems pertaining to the structure elucidation of simple organic compounds using 1H NMR spectroscopy techniques.

Book Suggested

a. Physical Chemistry G.M. Barrow. International Student Edition IMC Graw Hill.
b. Principles of Physical Chemistry Volume III, B.R.Puri,L.P.Sharma,and M.S.Pathania,Vishal Publication ,Jallandhar
c. Graduate Physical Chemistry,Volume III, L.R.Sharma and M.S .Pathania,2017
d. Fundamentals of Molecular spestroscopy,C.N .Banwell IV edition ,Mc Graw hill education
e. Quantum Chemistry by R.K.Prasad
f. Fundamental Principles of Spectroscopy, B.K.Sharma,Krishna Publication.

UG Semester I

Paper 1: Differential Calculus

UNIT I

Limit, continuity and differentiability of function of single variable, Cauchy's definition, Heine's definition, Uniform continuity, Borel's theorem, boundedness theorem, Bolzano's theorem, Intermediate value theorem, extreme value theorem, Darboux's intermediate value theorem for derivatives, Chain rule, indeterminate forms.

UNIT II

Rolle's theorem, Lagrange and Cauchy Mean value theorems, mean value theorems ofhigher order, Taylor's theorem with various forms of remainders, Successive differentiation, Leibnitz theorem, Maclaurin's and Taylor's series,

Limit and Continuity of functions of two variables, Differentiation of function of two variables, Necessary and sufficient condition for differentiability of functions two variables.

UNIT III

Partial differentiation, Euler's theorem on homogeneous function, Schwarz's and Young theorem, Taylor's theorem for functions of two variables with examples, Maxima and minima for functions of two variables, Lagrange multiplier method, Jacobians, Inverse function theorem and implicit function theorem.

UNIT IV

Tangents and normals, Asymptotes, Curvature, Envelops and evolutes, Tests for concavity and convexity, Points of inflexion, Multiple points, Parametric representation of curves and tracing of parametric curves, Tracing of curves in Cartesian and Polar forms.

UG Semester I

Paper 2: Integral Calculus

UNIT I

Definite integrals as limit of the sum, Riemann integral, Integrability of continuous and monotonic functions, Fundamental theorem of integral calculus, Mean value theorems of integral calculus, Differentiation under the sign of Integration.

UNIT II

Improper integrals, their classification and convergence, Comparison test, μ-test, Abel's test, Dirichlet's test, quotient test, Beta and Gamma functions.

UNIT III

Rectification, Volumes and Surfaces of Solid of revolution, Pappus theorem, Multiple integrals, change of order of double integration, Dirichlet's theorem, Liouville's theorem for multiple integrals.

UNIT IV

Vector Differentiation, Gradient, Divergence and Curl, Normal on a surface, Directional Derivative, Vector Integration, Theorems of Gauss, Green, Stokes and related problems.

Paper I : - Matrix & Differential Equations

Unit I

Type of Matrices, Elementary operation on matrices, Inverse of a matrix by elementary operations, rank of a matrix, Echelon and normal form, Eigen values, eigenvectors and characteristic equation of a matrix, Cayley-Hamilton theorem and its use in finding inverse of a matrix, system of linear homogeneous and non-homogeneous equations, Theorems on consistency of a system of linear equations.

Unit II

Complex functions and separation into real and imaginary parts, Exponential, direct and inverse trigonometric and hyperbolic functions, logarithmic function, Gregory's series, Summation of series.

Unit III

Formation of a differential equation, geometrical meaning of a differential equation, Equation of first order and first degree, Equations in which the variables are separable, Homogeneous equation, Linear equations, Exact differential equations and equations, reducible to the exact form, first order higher degree equations solvable for x, y, p.

Unit IV

Clairaut's equation and singular solutions, orthogonal trajectories, Linear differential equation with constant coefficients, homogeneous linear differential equations.

UG Semester II

Paper 2: Geometry

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Unit I

UNIT I

General equation of second degree, systems of conics, tracing of conics, confocal conics, polar equation of conics and its properties.

Unit II

Three-Dimensional Coordinates, Projection and Direction Cosine, Plane (Cartesian and vector form), Straight line in three dimension (Cartesian and vector form).

Unit III

Sphere, Cone and Cylinder.

Unit IV

Central conicoids, Paraboloids, Plane section of conicoids, Generating lines, Confocal conicoids, Reduction of second degree equation.

B.A./B.Sc. II (Semester III)
Mathematics
(Applicable from July 2019)

Paper I (Algebra)

Unit I

Equivalence relations and partitions, Congruence modulo n, Definition of a group with examples and simple properties, Subgroups, Generators of a group, Cyclic groups.

Unit II

Permutation groups, Even and odd permutations, The alternating group, Cayley's theorem, Direct products, Coset decomposition, Lagrange's theorem and its consequences, Fermat and Euler theorems

Unit III

Normal subgroups, Quotient groups, Homomorphism and isomorphism, Fundamental theorem of homomorphism, Theorems on isomorphism.

Unit IV

Rings, Subrings, Integral domains and fields, Characteristic of a ring, Ideal and quotient rings, Ring homomorphism, Field of quotient of an integral domain.

Paper II: Mathematical Methods

Unit I

Limit and Continuity of functions of two variables, Differentiation of function of two variables, Necessary and sufficient condition for differentiability of functions two variables, Schwarz's and Young theorem, Taylor's theorem for functions of two variables with examples, Maxima and minima for functions of two variables, Lagrange multiplier method, Jacobians.

Unit II

Existence theorems for Laplace transforms, Linearity of Laplace transform and their properties, Laplace transform of the derivatives and integrals of a function, Convolution theorem, inverse Laplace transforms, Solution of the differential equations using Laplace transforms.

Unit III

Fourier series, Fourier expansion of piecewise monotonic functions, Half and full range expansions, Fourier transforms (finite and infinite), Fourier integral.

Unit IV

Calculus of variations-Variational problems with fixed boundaries- Euler's equation for functionals containing first order derivative and one independent variable, Extremals, Functionals dependent on higher order derivatives, Functionals dependent on more than one independent variable, Variational problems in parametric form.

B.A./B.Sc. II (Semester IV)
Mathematics
(Applicable from January 2020)

Paper I: Differential Equations

Unit I

Second order linear differential equations with variable coefficients: Use of a known solution to find another, normal form, method of undetermined coefficient, variation of parameters, Series solutions of differential equations, Power series method.

Unit II

Bessel, Legendre and Hypergeometric functions and their properties, recurrence and generating relations.

Unit III

Origin of first order partial differential equations. Partial differential equations of the first order and degree one, Lagrange's solution, Partial differential equation of first order and degree greater than one. Charpit's method of solution, Surfaces Orthogonal to the given system of surfaces.

Unit IV

Origin of second order PDE, Solution of partial differential equations of the second and higher order with constant coefficients, Classification of linear partial differential equations of second order, Solution of second order partial differential equations with variable coefficients, Monge's method of solution.

Paper II: Mechanics

Unit I

Frame of reference, work energy principle, Forces in three dimensions, Poinsot's central axis, Wrenches, Null lines and planes.

Unit II

Virtual work, Stable and Unstable equilibrium, Catenary, Catenary of uniform strength.

Unit III

Velocities and accelerations along radial and transverse directions, and along tangential and normal directions, Simple Harmonic motion, Motion under other law of forces. Elastic strings, Motion in resisting medium, Constrained motion, Motion on smooth and rough plane curves.

Unit IV

Motion of particles of varying mass, Rocket motion, Central orbit, Kepler's laws of motion,, Motion of particle in three dimensions, Rotating frame of reference, Rotating Earth, Acceleration in terms of different coordinates systems.

Revised Structure and syllabi of

B.A. /B.Sc. (Semester V & VI)
Mathematics
(Applicable from July 2020)

Structure	
B.A. /B.Sc. Semester V	B.A./B.Sc. Semester VI
Paper I : **Numerical Analysis** Paper II: **Linear & Abstract Algebra** Paper III: **Linear Programming**	Paper I : **Analysis** Paper II: **Differential Geometry & Tensor Analysis** Paper III: **Discrete Mathematics**

Each paper carries 100 Marks (4 Credits)

Syllabus B.A. /B.Sc. (Semester V)

Paper I: Numerical Analysis

Unit I

Solution of equations: bisection, Secant, Regular Falsi, Newton Raphson's method, Newton's method for multiple roots, Interpolation, Lagrange and Hermite interpolation, Difference schemes, Divided differences, Interpolation formula using differences.

Unit II

Numerical differentiation, Numerical Quadrature: Newton Cotes Formulas, Gaussian Quadrature Formulas, System of Linear equations: Direct method for solving systems of linear equations (Gauss elimination, LU Decomposition, Cholesky Decomposition), Iterative methods (Jacobi, Gauss Seidel, Relaxation methods). The Algebraic Eigen value problem: Jacobi's method, Givens method, Power method.

Unit III

Numerical solution of Ordinary differential equations: Euler method, single step methods, Runge-Kutta method, Multi-step methods: Milne-Simpson method, Types of approximation: Last Square polynomial approximation, Uniform approximation, Chebyshev polynomial approximation.

Unit IV

Difference Equations and their solutions, Shooting method and Difference equation method for solving Linear second order differential equation with boundary conditions of first, second and third type.

Reference Books:

1. Numerical Methods for Engineering and scientific computation by M. K. Jain, S.R.K. Iyengar & R.K. Jain.
2. Introductory methods of Numerical Analysis by S. S. Sastry

Paper II: Linear & Abstract Algebra

Unit I
Automorphism, inner automorphism, automorphism groups and their computations, Conjugacy relations, Normaliser, Counting principle and the class equation of a finite group, Center of group of prime power order. Sylow's theorems.
Unit II
Prime and maximal ideals, Euclidean Rings, Principal ideal rings, Polynomial Rings, Polynomial over the Rational Field, The Eisenstein Criterion, Polynomial Rings over Commutative Rings, unique factorization domain.
Unit III
Vector spaces, Subspaces, Linear independence and dependence of vectors, Basis and Dimension, Quotient space, Linear transformations, The Algebra of linear transformations, rank nullity theorem, their representation as matrices.
Unit IV
Linear functionals, Dual space, Characteristic values, Cayley Hamilton Theorem, Inner product spaces, Cauchy-Schwarz inequality, Orthogonal vectors, Orthonormal sets and bases, Bessel's inequality for finite dimensional spaces, Gram-Schmidt orthogonalization process, Bilinear and Quadratic forms.

Reference book
1. Topics in Algebra by I. N. Herstein.
2. Linear Algebra by K. Hoffman and R. Kunze.

Paper III: Linear Programming

Unit I
Linear programming problems, Slack and surplus variables, Standard and matrix forms of linear programming problem, Basic feasible solution.
Unit II
Convex sets, Fundamental theorem of linear programming, Simplex method.
Unit III
Artificial variables, Big-M method, Two phase method, Revised simplex method.
Unit IV
Duality in linear programming problems, Dual simplex method, Primal-dual method integer programming.

Reference book:
1. Linear Programming by G. Hadley

Syllabus B.A. /B.Sc. (Semester VI)

Mathematics

(Applicable from January 2021)

Paper I : Analysis

Unit I

Definition and examples of metric spaces, Neighborhoods, Interior points, Limit Points, Open and closed sets, Convergent and Cauchy sequences, Completeness, Cantor's intersection theorem. Uniform convergence of sequences and series of functions, Uniform convergence and continuity, Uniform convergence and integration, Uniform convergence and differentiation, Power series.

Unit II

Stereographic projection, Continuity and Differentiability of complex functions, Analytic functions, Cauchy Riemann equations, Harmonic functions.

Unit III

Complex integration, Cauchy-Goursat theorem, Cauchy's Integral formula, Formulae for first, second and nth derivatives, Cauchy's Inequality, Maximum Modulus Theorem, Liouville's Theorem, Elementary functions, Mapping by elementary functions, conformal mapping.

Unit IV

Taylor and Laurent Series, Absolute and uniform convergence of Power series, Residues and Poles, Residue theorem, Zeros and poles of order m, Evaluation of improper real integrals, Definite integrals involving sines and cosines.

Reference book:

1. Mathematical Analysis by Shanti Narain.
2. Complex variable and applications by Brown & Churchill.

Paper II: Differential Geometry & Tensor Analysis

Unit I

Local theory of curves-Space curves, Examples, Plane Curves, tangent and normal and binormal, Osculating Plane, normal plane and rectifying plane, Helices, Serret-Frenet apparatus, contact between curve and surfaces, tangent surfaces, involutes and evolutes of curves, Bertrand curves, Intrinsic equations, fundamental existence theorem for space curves.

Unit II

Metric-first fundamental form and arc length, Direction coefficients, families of curves, intrinsic properties, geodesics, canonical geodesic equations, normal properties of geodesics, geodesics curvature, Gauss-Bonnet theorem, Gaussian curvature, normal curvature, Meusneir's theorem, mean curvature, Gaussian curvature, umbilic points, lines of curvature, Rodrigue's formula, Euler's theorem.

Unit III

Tensor algebra: Vector spaces, the dual spaces, tensor product of vector spaces, transformation formulae, contraction, special tensor, inner product, associated tensor.

Tensor Analysis: Contravariant and covariant vectors and tensors, Mixed tensors, Symmetric and skew-symmetric tensors, Algebra of tensors, Contraction and inner product, Quotient theorem, Reciprocal tensors, Christoffel's symbols, Covariant differentiation.

Unit IV

Gradient of scalars, Divergence of a contra-variant vector, covariant vector and conservative vectors, Laplacian of an invariant, curl of a covariant vector, irrotational vector, Riemannian space, Riemannian curvatures and their properties, Ricci tensor, and scalar curvature, Einstein space and Einstein tensor, Geodesics.

Reference book:

1. An introduction to Differential Geometry by T. J. Willmore

Paper III: Discrete Mathematics

Unit I

Propositional Logic- Proposition logic, basic logic, logical connectives, truth tables, tautologies, contradiction, normal forms (conjunctive and disjunctive), modus ponens and modus tollens, validity, predicate logic, universal and existential quantification, proof by implication, converse, inverse contrapositive, contradiction, direct proof by using truth table.

Relation- Definition, types of relation, domain and range of a relation, pictorial representation of relation, properties of relation, partial ordering relation.

Unit II

Boolean Algebra- Basic definitions, Sum of products and products of sums, Logic gates and Karnaugh maps.

Graphs- Simple graph, multi graph, graph terminology, representation of graphs, Bipartite, regular, planar and connected graphs, connected components in a graph, Euler graphs, Hamiltonian path and circuits, Graph colouring, chromatics number, isomorphism and homomorphism of graphs.

Unit III

Combinatories- Inclusion- exclusion, recurrence relations (nth order recurrence relation with constant coefficients, Homogeneous recurrence relations, Inhomogeneous recurrence relations), generating function (closed form expression, properties of G.F., solution of recurrence relations using G.F. solution of combinatorial problem using G.F.)

Unit IV

Finite Automata- Basic concepts of automation theory, Deterninistic Finite Automation (DFA), transition function, transition table, Non Deterministic Finite Automata (NDFA), Mealy and Moore machine, Minimization of finite automation.

Reference book:

1. Discrete Mathematics by C. L.Liu.
2. Discrete Mathematics with computer application by Trembley and Manohar.