

| Subject Code | 1 <sup>st</sup> Semester             | Periods   |          |          | Credits   | Ext.       | Int.       | Total       |
|--------------|--------------------------------------|-----------|----------|----------|-----------|------------|------------|-------------|
|              |                                      | L         | T        | P        |           |            |            |             |
| BBSC1-101    | Inorganic Chemistry                  | 3         | 0        | 0        | 3         | 60         | 40         | 100         |
| BBSC1-102    | Organic Chemistry                    | 3         | 0        | 0        | 3         | 60         | 40         | 100         |
| BBSC1-103    | Mathematical Physics                 | 3         | 0        | 0        | 3         | 60         | 40         | 100         |
| BBSC1-104    | Mechanics-I                          | 3         | 0        | 0        | 3         | 60         | 40         | 100         |
| BBSC1-105    | English                              | 3         | 0        | 0        | 3         | 60         | 40         | 100         |
| BBSC1-106    | Solid Geometry                       | 3         | 0        | 0        | 3         | 60         | 40         | 100         |
| BBSC1-107    | Differential Calculus                | 3         | 0        | 0        | 3         | 60         | 40         | 100         |
| BBSC1-108    | Punjabi /OR Punjab History & Culture | 3         | 0        | 0        | 3         | 60         | 40         | 100         |
| BBSC1-109    | Chemistry Lab.-I                     | 0         | 0        | 4        | 2         | 40         | 60         | 100         |
| BBSC1-110    | Physics Lab.-I                       | 0         | 0        | 4        | 2         | 40         | 60         | 100         |
| <b>Total</b> |                                      | <b>24</b> | <b>0</b> | <b>8</b> | <b>28</b> | <b>560</b> | <b>440</b> | <b>1000</b> |

MRSPTU

## INORGANIC CHEMISTRY

Subject Code: BBSC1-101

L T P C  
3 0 0 3

Duration: 40 Hrs.

### Unit-I

#### Atomic Structure:

de Broglie equation, Heisenberg's Uncertainty Principle and its significance. Schrödinger's wave equation and its derivation, significance of  $\psi$  and  $\psi^2$ . Quantum numbers. Normalized and orthogonal wave functions. Sign of wave functions. Radial and angular wave functions and distribution curves. Shapes of s, p, d and f orbitals.

Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau principle and its limitations.

### Unit-II

#### Chemical Periodicity:

Effective nuclear charge, shielding or screening effect (Slater rules), variation of effective nuclear charge in periodic table.

Atomic and ionic radii, Ionization enthalpy, Electron gain enthalpy and their trend in groups and periods.

Electronegativity and various scales. Variation of electronegativity with bond order, partial charge, hybridization, group electronegativity.

### Unit-III

#### Chemical Bonding-I:

**Ionic bond:** General characteristics of ionic compounds, size effects, radius ratio rule and its limitations. Efficiency of packing, Hexagonal close packing, Cubic close packing. Structures of different crystal lattices, Sodium chloride, Cesium chloride, Wurtzite, Zinc blende, Fluorite, Rutile, Cristobalite, Nickel arsenide, Pervoskite, Rhenium oxide, Calcium carbide, The calcite and aragonite structures.

Born-Landé equation with derivation and importance of Kapustinskii expression for lattice energy. Madelung constant, Born-Haber cycle and its application, Solvation energy.

### Unit-IV

#### Chemical Bonding-II:

**Covalent bond:** Lewis structure, Valence Bond theory, VSEPR theory (Prediction of structures and variation of bond angles on the basis of VSEPR theory, Shortcomings of VSEPR theory), Hybridization, Molecular orbital theory (LCAO method). Molecular orbital diagrams of diatomic and simple polyatomic molecules ( $\text{Be}_2$ ,  $\text{N}_2$ ,  $\text{O}_2$ ,  $\text{F}_2$ ,  $\text{LiH}$ ,  $\text{NO}$ ,  $\text{CO}$ ,  $\text{HCl}$ ,  $\text{NO}_2$ ,  $\text{BeH}_2$ ,  $\text{NO}_2^-$ ), Formal charge, Covalent character in ionic compounds, polarizing power and polarizability. Fajan's rules and consequences of polarization. Ionic character in covalent compounds (Bond moment, dipole moment, Percentage ionic character)

**Metallic Bond:** Valence bond and band theories. Semiconductors and insulators, defects in solids.

**Weak Interactions:** van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interaction, Hydrogen bonding.

#### Recommended Books:

1. D.F.C. Shriver, P.W. Atkins and C.H. Langford, 'Inorganic Chemistry', ELBS Oxford, 1991.
2. J.E. Huheey, E.A. Keiter, R.L. Keiter, 'Inorganic Chemistry', 4<sup>th</sup> Edn., Pearson Education, Singapore, 1999.

3. J.D. Lee, 'Concise Inorganic Chemistry', ELBS, Oxford, 1994.

## ORGANIC CHEMISTRY

**Subject Code: BBSC1-102**

**L T P C**  
**3 0 0 3**

**Duration: 40 Hrs.**

### Unit-I

#### **Structure and Bonding:**

Hybridization, bond lengths, bond angles, bond energy, localized and delocalized chemical bond, van der Waals interactions, inclusion compounds, clathrates, charge transfer complexes resonance, hyperconjugation, aromaticity, inductive and field effects, hydrogen bonding.

#### **Mechanism of Organic Reactions:**

Curved arrow notation, drawing electron movements with arrows, half-headed and double-headed arrows, homolytic and heterolytic bond breaking. Types of reagents- electrophiles and nucleophiles. Types of organic reactions. Energy considerations. Reactive intermediates (carbocations, carbanions, free radicals, carbenes, arynes and nitrenes). Assigning formal charges on intermediates and other ionic species.

Methods of determination of reaction mechanism (product analysis, intermediates, isotope effects, kinetic and stereochemical studies).

### Unit-II

#### **Stereochemistry of Organic Compounds:**

Isomerism and its types, Optical isomerism - elements of symmetry, molecular chirality, enantiomers, stereogenic center, optical activity, properties of enantiomers, chiral and achiral molecules with two stereogenic centers, diastereomers, threo and erythro, diastereomers, meso compounds, resolution of enantiomers, inversion, retention and racemization. Relative and absolute configuration, sequence rules, D & L and R & S systems of nomenclature.

Geometric isomerism - determination of configuration of geometric isomers. E & Z system of nomenclature, geometric isomerism in oximes and alicyclic compounds. Conformational isomerism - conformational analysis of ethane and n-butane; conformational analysis of cyclohexane, axial and equatorial bonds, conformation of mono substituted cyclohexane derivative. Newman projection and Sawhorse formulae, Fischer and flying wedge formulae. Difference between configuration and conformation.

### Unit-III

#### **Alkanes and Cycloalkanes:**

Introduction, IUPAC nomenclature, Isomerism and classification of carbon atoms of alkanes. Sources, methods of formation (with special reference to Wurtz reaction, Kolbe reaction, Corey-House reaction and decarboxylation of carboxylic acids). Physical properties and chemical reactions of alkanes.

Mechanism of free radical halogenation of alkanes: orientation, reactivity and selectivity.

Cycloalkanes - nomenclature, methods of formation, chemical reactions, Baeyer's strain theory and its limitations. Ring strain in small rings (cyclopropane and cyclobutane), theory of strainless rings. The case of cyclopropane ring; banana bonds.

### Unit-IV

#### **Alkenes, Cycloalkenes, Dienes and Alkynes:**

*Alkenes* Nomenclature, methods of synthesis (mechanisms of dehydration of alcohols and dehydrohalogenation of alkyl halides, regioselectivity in alcohol dehydration. Saytzeff rule,

Hofmann elimination), physical properties and relative stabilities of alkenes. Chemical reactions of alkenes - mechanisms involved in hydrogenation, electrophilic and free radical additions, Markownikoff's rule, hydroboration-oxidation, oxymercuration-reduction. Epoxidation, ozonolysis, hydration, hydroxylation and oxidation with  $\text{KMnO}_4$ , Polymerization of alkenes. Substitution at the allylic and vinylic positions of alkenes. Industrial applications of ethylene and propene.

*Cycloalkenes* Methods of formation, conformation and Chemical reactions of cycloalkenes.

*Dienes* Nomenclature and classification of dienes: isolated, conjugated and cumulated dienes.

Structure of allenes and butadiene, methods of formation, polymerization. Chemical reactions – 1, 2 and 1,4 additions, Diels-Alder reaction.

*Alkynes* Nomenclature, structure and bonding in alkynes. Methods of formation. Chemical reactions of alkynes, acidity of alkynes. Mechanism of electrophilic and nucleophilic addition reactions, hydroboration oxidation, metal-ammonia reductions, oxidation and polymerization.

#### Recommended Books:

1. Morrison and Boyd, 'Organic Chemistry', Prentice Hall.
2. Solomons, 'Fundamentals of Organic Chemistry', John Wiley.
3. F.A. Carey, 'Organic Chemistry', McGraw Hill, Inc.
4. L.G. Wade Jr., 'Organic Chemistry', Prentice Hall.
5. S.M. Mukherji, S.P. Singh and R.P. Kapoor, 'Organic Chemistry', Vol.-I, II & III, Wiley Eastern Ltd. (New Age International).
6. Stritwieser, Heathcock and Kosover, 'Introduction to Organic Chemistry', Macmillan.

### MATHEMATICAL PHYSICS

Subject Code: BBSC1-103

L T P C  
3 0 0 3

Duration: 40 Hrs.

#### Unit-I

**First Order and Second Order Ordinary Differential equations:** First Order Differential Equations and Integrating Factor. Homogeneous Equations with constant coefficients. Wronskian and general solution. Statement of existence and Uniqueness Theorem for Initial Value Problem.

**Calculus of Functions of more than one Variable:** Partial derivatives, exact and inexact differentials. Integrating factor, with simple illustration. Constrained Maximization using Lagrange Multipliers.

#### Unit-II

**Vector Calculus:** Recapitulation of vectors: Properties of vectors under rotations. Scalar product and its invariance under rotations. Vector product, Scalar triple product and their interpretation in terms of area and volume respectively. Scalar and Vector fields.

#### Unit-III

**Vector Differentiation:** Directional derivatives and normal derivative. Gradient of a scalar field and its geometrical interpretation. Divergence and curl of a vector field. Del and Laplacian operators. Vector identities.

**Vector Integration:** Ordinary Integrals of Vectors. Multiple integrals, Jacobian. Notion of infinitesimal line, surface and volume elements. Line, surface and volume integrals of Vector fields. Flux of a vector field. Gauss' divergence theorem, Green's and Stokes Theorems and their applications.

**Unit-IV**

**Orthogonal Curvilinear Coordinates:** Orthogonal Curvilinear Coordinates. Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and Cylindrical Coordinate Systems.

**Dirac Delta function:** Dirac Delta function and its properties: Definition of Dirac delta function. Representation as limit of a Gaussian function and rectangular function. Properties of Dirac delta function.

**Recommended Books:**

1. G.B. Arfken, H.J. Weber, F.E. Harris, 'Mathematical Methods for Physicists', 7<sup>th</sup> Edn., Elsevier, 2013.
2. E.A. Coddington, 'An Introduction to Ordinary Differential Equations', PHI learning, 2009.
3. George F. Simmons, 'Differential Equations', McGraw Hill, 2007.
4. James Nearing, 'Mathematical Tools for Physics', Dover Publications, 2010.
5. D.A. McQuarrie, 'Mathematical Methods for Scientists and Engineers', Viva Book, 2003.
6. D.G. Zill and W.S. Wright, 'Advanced Engineering Mathematics', 5<sup>th</sup> Edn., Jones and Bartlett Learning, 2012.
7. Goswami, 'Mathematical Physics', 1<sup>st</sup> Edn., Cengage Learning.
8. S. Pal and S.C. Bhunia, 'Engineering Mathematics', Oxford University Press, 2015.
9. Erwin Kreyszig, 'Advanced Engineering Mathematics', Wiley India, 2008.
10. K.F. Riley & M.P. Hobson, 'Essential Mathematical Methods', Cambridge Univ. Press, 2011.

**MECHANICS-I**

**Subject Code: BBSC1-104**

**L T P C  
3 0 0 3**

**Duration: 40 Hrs.**

**Unit-I**

**Fundamentals of Dynamics:** Reference frames. Inertial frames; Review of Newton's Laws of Motion. Galilean transformations; Galilean invariance. Momentum of variable- mass system: motion of rocket. Motion of a projectile in Uniform gravitational field. Conservation of Energy, Conservative forces, Dynamics of a system of particles. Centre of Mass. Principle of conservation of momentum. Impulse. Angular Momentum about the Centre of mass, Rotational invariance, Shape of Galaxy.

**Unit-II**

**Work and Energy:** Work and Kinetic Energy Theorem. Conservative and non- conservative forces. Potential Energy. Energy diagram. Stable and unstable equilibrium. Elastic potential energy. Force as gradient of potential energy. Work & Potential energy. Work done by non-conservative forces. Law of conservation of Energy.

**Elastic and Inelastic Scattering:** Types of scattering and conservation laws, Laboratory and centre of mass systems, collision of particles which stick together, General elastic collision of particles of different mass, Cross-section of elastic scattering, Rutherford scattering.

**Unit-III**

**Rotational Dynamics:** Angular momentum of a particle and system of particles. Torque. Principle of conservation of angular momentum. Rotation about a fixed axis. Moment of Inertia. Calculation of moment of inertia for rectangular, cylindrical and spherical bodies. Kinetic energy of rotation. Motion involving both translation and rotation. Cylinder on an accelerated rough

plane, Behavior of angular momentum vector, Principal axes and Euler's equations, Elementary Gyroscope, Symmetrical Top.

#### Unit-IV

**Elasticity:** Hooke's Law-Stress-strain Diagram-Elastic Moduli-Relation between elastic Constants-Poisson's Ratio-Expression for Poisson's ratio in terms of elastic constants - Work done in stretching and work done in twisting a Wire-Twisting couple on a cylinder - Determination of Rigidity modulus by static torsion - Torsional Pendulum-Determination of Rigidity modulus and moment of inertia -  $q$ ,  $\eta$ , and  $\sigma$  by Searles method.

#### Recommended Books:

1. D. Kleppner, R.J. Kolenkow, 'An Introduction to Mechanics', McGraw Hill, 1973.
2. C. Kittel, W. Knight, et.al., 'Mechanics, Berkeley Physics', Vol.-1, Tata McGraw Hill, 2007.
3. Resnick, Halliday and Walker, 'Physics', 8<sup>th</sup> Edn., Wiley, 2008.
4. G.R. Fowles and G.L. Cassiday, 'Analytical Mechanics', Cengage Learning, 2005.
5. R.P. Feynman, R.B. Leighton, M. Sands, 'Feynman Lectures', Vol. I, Pearson Education, 2008.
6. R. Resnick, 'Introduction to Special Relativity', John Wiley and Sons, 2005.
7. Ronald Lane Reese, 'University Physics', Thomson Brooks/Cole, 2003.
8. D.S. Mathur, 'Mechanics', S. Chand and Company Limited, 2000.
9. F.W Sears, M.W Zemansky, H. D Young, 'University Physics', 13<sup>th</sup> Edn., Addison Wesley, 1986.
10. J.W. Jewett, R.A. Serwa, 'Physics for Scientists and Engineers with Modern Physics', Cengage Learning, 2010.
11. M.R. Spiegel, 'Theoretical Mechanics', Tata McGraw Hill, 2006.

#### ENGLISH

Subject Code: BBSC1-105

L T P C  
3 0 0 3

Duration: 40 Hrs.

#### Unit-I

##### Literature:

***The Poetic Palette* (Orient Black Swan, Second Edition, 2016)**

The following poems from this anthology are prescribed:

1. Apparently with No Surprise: Emily Dickinson
2. Fool and Flea: Jeet Thayil
3. The Soul's Prayer: Sarojini Naidu
4. I Sit and Look Out: Walt Whitman
5. Women's Rights: Annie Louise Walker
6. Pippa's Song: Robert Browning

##### Vocabulary

Antonyms; Synonyms; One-word substitution; Homophones/Homononyms; Abbreviations

#### Unit-II

##### Literature:

**(b) *Prose Parables* (Orient Black Swan, 2013)**

The following stories from the above volume are prescribed:

1. The Eyes Are Not Here: Ruskin Bond
2. Grief: Anton Chekov

3. The Doctor's Word: R.K. Narayan
4. The Doll's House: Katherine Mansfield
5. Dusk: H.H. Munroe (Saki)
6. The Kabuli wallah: Rabindranath Tagore

**Grammar:**

Parts of Speech; Articles, Determiners; Modals; Modifiers; Prepositions; Voice; Transformation of sentences

**Unit-III**

Close Reading; Comprehension; Summarizing; Paraphrasing; Analysis and Interpretation; Translation (from Hindi/Punjabi to English and vice-versa)

**Unit-IV**

Essay Writing -Descriptive/Narrative/Argumentative; Business letters; Précis Writing.

**Recommended Books:**

1. John Eastwood, 'Oxford Practice Grammar', 2014.
2. 'Business English', Pearson, 2008.
3. 'Language, Literature and Creativity', Orient Black Swan, 2013.
4. Gauri Mishra, Ranjana Kaul, Brati Biswas, 'Language through Literature (forthcoming)'.
5. Liz Hamp-Lyons and Ben Heasley, 'Study Writing', Cambridge University Press, 2006.

**SOLID GEOMETRY**

**Subject Code: BBSC1-106**

**L T P C**  
**3 0 0 3**

**Duration: 40 Hrs.**

**Unit-I**

The concept of co-ordinates, co-ordinate of a point in space, distance between two points. Plane: Definition of a plane, Normal form of the equation of a plane, Transformation from general form to normal form, Equation of plane in terms of its intercepts on the axis, Equations of the plane through the given points, Length of the perpendicular from a given point to a given plane, Bisectors of angles between two planes, Combined equation of two planes, Orthogonal projection on a plane.

**Unit-II**

**Sphere:** Definition and equation of the sphere; Equation of the sphere through four given points; Plane sections of a sphere; Intersection of two spheres; Equation of a circle; Sphere through a given circle; Intersection of a sphere and a line; Power of a point; Tangent plane; Plane of contact; Polar plane; Pole of a plane; Conjugate points; Conjugate planes; Angle of intersection of two spheres; Conditions for two spheres to be orthogonal; Radical plane; Coaxial system of spheres.

**Unit-III**

**Cone:** Definitions of a cone; vertex; guiding curve; generators; Equation of the cone with a given vertex and guiding curve; Enveloping cone of a sphere; Equations of cones with vertex at origin are homogenous; Condition that the general equation of the second degree should represent a cone; Condition that a cone may have three mutually perpendicular generators; Intersection of a line and a quadric cone; Tangent lines and tangent plane at a point; Condition that a plane may touch a cone; Reciprocal cones; Intersection of two cones with a common vertex; Right circular cone; Equation of the right circular cone with a given vertex; axis and semi-vertical angle.

**Unit-IV**

**Cylinder:** Definition of a cylinder, Equation to the cylinder whose generators intersect a given conic and are parallel to a given line; Enveloping cylinder of a sphere; The right circular cylinder; Equation of the right circular cylinder with a given axis and radius.

**Recommended Books:**

1. Shanti Narayan and P.K. Mittal, 'Analytical Solid Geometry', 17<sup>th</sup> Edn., S. Chand & Company, 2007.
2. P.K. Jain, 'A Textbook of Analytical Geometry of Three Dimensions', New Age International, 2005.

**DIFFERENTIAL CALCULUS**

**Subject Code: BBSC1-107**

**L T P C  
3 0 0 3**

**Duration: 40 Hrs.**

**Unit-I**

Definition of a sequence. limit of a sequence, theorems on limits of sequences, bounded, monotonic sequences. Least upper bound and greatest lower bound of a sequence. Limit superior, limit inferior. Nested Intervals. Cauchy's convergence criterion, infinite series.

**Unit-II**

Limits of Functions,  $\square \square \square$  definition, right- and left-hand limits. Theorems on limits. Infinity. Special Limits. Continuity,  $\square \square \square$  definition, right- and left-hand Continuity, continuity in an interval, theorems on continuity, piecewise continuity, uniform Continuity.

**Unit-III**

The concept and definition of a derivative, right- and left-hand derivatives, differentiability in an interval, piecewise differentiability, differentials, differentiation of composite functions, implicit differentiation, mean value theorems, Taylor theorem, applications.

**Unit-IV**

Functions of two or more variables, neighborhoods, regions, limits, iterated limits, continuity, uniform continuity, partial derivatives, higher-order partial derivatives, differentials, theorems on differentials, differentiation of composite functions, Euler's theorem on homogeneous functions. Implicit functions, Jacobians, partial derivatives using Jacobians, theorems on Jacobians, applications.

**Recommended Books:**

1. Robert Wrede and Murray R. Spiegel, 'Advanced Calculus', 3<sup>rd</sup> Edn., Schaum's Outline Series, McGraw Hill, 2010.
2. Maurice D. Weir, Frank R. Giordano and Joel Hass, Thomas, 'Calculus', 11<sup>th</sup> Edn., Pearson, 2008.
3. James Stewart, 'Calculus', 5<sup>th</sup> Edn., Brooks/Cole (Thomson), 2003.
4. M.R. Spiegel, 'Theoretical Mechanics', Tata McGraw Hill, 2006.



**PUNJAB HISTORY & CULTURE**

**Subject Code: BBSC1-108**

**L T P C**  
**3 0 0 3**

**Duration: 40 Hrs.**

**Unit-I**

Physical Features of the Punjab and impact on history.  
Sources of the ancient history of Punjab.

**Unit-II**

**Harappan Civilization:** Town planning; Social, economic and religious life of the India valley people

**The indo-Aryans:** original home and settlement in Punjab.

**Unit-III**

Social, Religious and Economic life during later Rig Vedic age.  
Social, Religious and Economic life during later Vedic Age.

**Unit-IV**

Teaching and impact of Buddhism  
Jainism in the Punjab.

**Recommended Books:**

1. L. Joshi, 'History and Culture of the Punjab, Art-1, Patiala', 3<sup>rd</sup> Edn., 1989.
2. L.M. Joshi and Fauja Singh, History of Punjab, Vol.-I, Patiala, 1977.
3. Budha Parkash, 'Glimpses of Ancient Punjab, Patiala', 1983.
4. B.N. Sharma, 'Life in Northern India, Delhi', 1966.

**CHEMISTRY LAB.-I**

**Subject Code: BBSC1-109**

**L T P C**  
**3 0 0 3**

**Inorganic Chemistry:** Semi Micro analysis. Cation analysis, Separation and identification of ions from groups I, II, III, IV, V, and VI. Anionic analysis. Four ions with no interference.

**Organic Chemistry Laboratory Techniques:**

*Determination of Melting Point*

Naphthalene 80-82°C

Cinnamic acid 132.5-133 °C

Benzoic acid 121.5-122 °C

Salicylic acid 157.5-158 °C

Urea 132.5-133 °C

Acetanilide 113.5-114 °C

Succinic Acid 184.5-185 °C

*m*-dinitro benzene 90 °C

*p*-dichlorobenzene 52 °C

Aspirin 135 °C

*Determination of Boiling Point*

Ethanol 78 °C

Cyclohexane 81.4 °C

Benzene 80 °C

Toluene 110°C

**PHYSICS LAB.-I**

**Subject Code: BBSC1-110**

**L T P C**

**3 0 0 3**

*At least 06 experiments from the following:*

1. Measurements of length (or diameter) using Vernier caliper, screw gauge, and travelling microscope. Use of Plumb line and Spirit level.
2. Analysis of experimental data by:
  - a) Fitting the given data to a straight line,
  - b) Study probable error in observations.
3. To determine the height of an inaccessible object using a sextant.
4. To determine the horizontal distance of an object using a sextant.
5. To determine the vertical distance of an object using a sextant.
6. To verify the law of vibrating string by Melde's experiment.
7. To setup CRO for Sine and Square wave and to find their frequency and amplitude.
8. To study the Motion of Spring and calculate (a) Spring constant, (b)  $g$  and (c) Modulus of rigidity.
9. To establish a relation between angular acceleration  $\alpha$  and torque  $\tau$ , and hence to find out the moment of Inertia of flywheel.
10. Study the dependence of the moment of Inertia on distribution of mass (by noting the time periods of oscillations) using objects of various shape but of same mass.
11. To determine the Young's Modulus of a Wire by Optical Lever Method.
12. To determine the Young's Modulus of a Wire by Searle's method.
13. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.

**Recommended Books:**

1. B.L. Flint and H.T. Worsnop, 'Advanced Practical Physics for Students', Asia Publishing House, 1971,
2. 'Advanced Level Physics Practicals', Michael Nelson and Jon M. Ogborn, 4<sup>th</sup> Edn., Heinemann Educational Publishers, reprinted 1985.
3. S. Panigrahi & B. Mallick, 'Engineering Practical Physics', Cengage Learning India Pvt. Ltd. 2015,
4. G.L. Squires, 'Practical Physics', 4<sup>th</sup> Edn., Cambridge University Press, 2015.
5. I. Prakash & Ramakrishna, 'A Text Book of Practical Physics', 11<sup>th</sup> Edn., Kitab Mahal.
6. C.L. Arora, 'B.Sc. Practical Physics', S. Chand & Co.