Contents

Preface *v*
Visual Walkthrough *xx*
Abbreviations *xxiii*

1. Drawing Instruments and Sheet Layout **1.1**
1.1 Introduction 1.1
1.2 Drawing Instruments 1.1
1.3 Drawing Board and Table 1.2
1.4 Mini-Drafter 1.2
1.5 Drawing Sheet 1.3
1.6 Drawing Pencils 1.4
1.7 Compass 1.4
1.8 Dividers 1.6
1.9 Protractors 1.7
1.10 Rulers (Scales) 1.9
1.11 French Curves 1.10
1.12 Set-Squares 1.11
1.13 Erasers 1.11
1.14 Drawing Sheet Fasteners (Drawing Pins,Clips and Adhesive Tapes) 1.12
1.15 Templates 1.12
1.16 Pencil Cutters 1.12
1.17 Sandpaper Pads 1.13
1.18 Brush or Towel 1.13
1.19 General Preparation for Drawing 1.13
1.20 Sheet Layout *1.13*
1.21 Title Block *1.15*
1.22 Space for Text *1.15*
1.23 Item References on Drawing and Item Lists *1.17*
1.24 Folding of Drawing Sheets *1.17*
1.25 Conclusions *1.17*
Review Questions *1.17*

Exercise 1.20
Multiple-Choice Questions 1.21

2. Lines, Lettering and Dimensioning **2.1**
2.1 Introduction *2.1*
2.2 Lines *2.1*
2.3 Configurations of Lines *2.1*
2.4 Drafting of Lines *2.2*
2.5 Types of Lines and their Applications in Mechanical Engineering Drawing *2.3*
2.6 Order of Priority of Coinciding Lines *2.4*
2.7 Lettering *2.4*
2.8 Single-Stroke Letters *2.6*
2.9 Rules for Lettering *2.6*
2.10 Dimensioning *2.7*
2.11 Dimensioning Terminology and Method of Execution *2.7*
2.12 Placing of Dimensions *2.8*
2.13 General Rules of Dimensioning *2.9*
2.14 Method of Dimensioning Some Common Features *2.12*
2.15 Arrangement of Dimensions *2.13*
Review Questions 2.14
Exercise 2.15
Multiple-Choice Questions 2.15

3. Geometrical Constructions **3.1**
3.1 Introduction *3.1*
3.2 Perpendicular Bisector of a Line *3.1*
3.3 Perpendiculars to a Line *3.1*
3.4 Parallel Lines *3.3*
3.5 Divide a Line *3.4*
3.6 Division of Line in Proportional Parts *3.4*
3.7 Bisecting an Angle *3.5*
3.8 Finding Centre of an Arc *3.5*
3.9 Tangent to a Circle from a Point on it *3.6*
3.10 Tangent to a Circle from a Point Outside it *3.6*
3.11 Tangent to an Arc of Inaccessible Centre, from a Point on it *3.6*
3.12 Tangent to Two Circles of Unequal Radii *3.7*
3.13 An Arc of Given Radius to Connect Two Straight Lines *3.7*
3.14 An Arc to Connect a Line Tangential to it and a Given Point *3.8*
3.15 An Arc of Given Radius to Connect Line with an arc or Circle *3.8*
3.16 An Arc of Given Radius to Connect Two Circles *3.8*
3.17 Polygons *3.9*
3.18 Construction of Regular Polygons (General Method) *3.10*
3.19 Construction of Triangle of Three Given Sides *3.11*
3.20 Equilateral Triangle of a Given Side *3.11*
3.21 Rectangle/Square of Given Sides *3.11*
3.22 Square of a Given Diagonal *3.12*

3.23 Construction of a Regular Pentagon (Special Method) *3.12*
3.24 Construction of a Regular Hexagon (Special Method) *3.13*
3.25 Inscribe Regular Polygons in a Circle *3.14*
3.26 Inscribe a Regular Octagon in a Square *3.16*
3.27 Circumscribe Regular Polygons on a Circle *3.16*
3.28 Miscellaneous Problems/Applications *3.16*
Review Questions *3.17*
Exercise *3.17*
Multiple-Choice Questions *3.19*

4. Scales **4.1**
4.1 Introduction *4.1*
4.2 Representation of Scales *4.1*
4.3 Representative Fraction (R.F.) *4.2*
4.4 Data Required for Construction of Scales *4.2*
4.5 Unit of Measurements *4.3*
4.6 Types of Scales *4.3*
4.7 Plain Scale *4.3*
4.8 Construction of a Plain Scale *4.3*
4.9 Diagonal Scale *4.8*
4.10 Principle of Diagonal Scale (Fig. 4.12) *4.8*
4.11 Construction of Diagonal Scale *4.9*
4.12 Comparative Scale *4.17*
4.13 Construction of Comparative Scale *4.17*
4.14 Vernier Scale *4.20*
4.15 Construction of Vernier Scale *4.20*
4.16 Scale of Chords *4.23*
4.17 Construction of Scale of Chords (Fig. 4.32) *4.23*
4.18 Application of Scale of Chords *4.23*
Review Questions *4.24*
Exercise *4.24*
Multiple-Choice Questions *4.26*

5. Conic Sections **5.1**
5.1 Introduction *5.1*
5.2 Cone *5.1*
5.3 Circle *5.1*
5.4 Isosceles Triangle *5.2*
5.5 Ellipse and its Application *5.2*
5.6 Parabola and its Application *5.3*
5.7 Hyperbola and its Application *5.4*
5.8 Construction of Ellipse *5.6*
5.9 Locate Minor Axis of the Ellipse When its Major Axis and Distance between Foci are Given *5.10*
5.10 Determine Distance between Foci of an Ellipse when Major and Minor Axes are Given *5.11*
5.11 Locate Major Axis of the Ellipse When its Minor Axis and Distance between Foci are Given *5.11*
5.12 Locate Center, Major Axis and Minor Axis of the Given Ellipse *5.12*

5.13 Tangent and Normal to an Ellipse Through a Point on it *5.12*
5.14 Draw Tangents to an Ellipse from a Point Outside it *5.13*
5.15 Curve Parallel to an Ellipse *5.13*
5.16 Eccentricity of a Given Ellipse *5.13*
5.17 Conjugate Diameters *5.14*
5.18 Construction of Parabola *5.14*
5.19 Axis of the Parabola *5.18*
5.20 Focus and Directrix of the Parabola *5.18*
5.21 Tangent and Normal through a Point on the Parabola *5.18*
5.22 Tangents from a Point Outside the Parabola *5.19*
5.23 Ordinate, Double Ordinate, Abscissa and Latus Rectum *5.19*
5.24 Construction of Hyperbola *5.20*
5.25 Locate Asymptotes and Directrix of the Hyperbola *5.25*
5.26 Tangent and Normal through a Point on the Hyperbola *5.25*
5.27 Determine Eccentricity of a Given Hyperbola *5.26*
5.28 Miscellaneous Problems *5.26*
Review Questions *5.33*
Exercise *5.33*
Multiple-Choice Questions *5.35*

6. Engineering Curves **6.1**
6.1 Introduction *6.1*
6.2 Cycloidal Curves *6.1*
6.3 Cycloid *6.1*
6.4 Epicycloid *6.2*
6.5 Hypocycloid *6.3*
6.6 Involute *6.5*
6.7 Spiral *6.6*
6.8 Archemedian Spiral *6.6*
6.9 Logarithmic Spiral *6.7*
6.10 Miscellaneous Problems *6.9*
Exercise 6A *6.14*
6.11 LOCI of Points *6.16*
Review Questions *6.22*
Exercise 6B *6.22*
Multiple-Choice Questions *6.23*

7. Orthographic Projections **7.1**
7.1 Projection *7.1*
7.2 Pictorial View and Multi-View *7.1*
7.3 Orthographic Projection *7.2*
7.4 Multi-View Projection *7.2*
7.5 Terminology *7.3*
7.6 First-Angle Projection *7.4*
7.7 Features of First-Angle Projection *7.5*
7.8 Third-Angle Projection *7.5*

7.9 Features of Third-Angle Projection *7.7*
7.10 Second-Angle and Fourth-Angle Projections *7.7*
7.11 Symbols for Orthographic Projection *7.7*
7.12 Reference Arrows Method *7.8*
7.13 Assumptions *7.9*
7.14 General Preparation for Multi-View Drawings *7.9*
7.15 Miscellaneous Problems *7.10*
Exercise 7A 7.14
7.16 Sectional Views *7.16*
7.17 Representation of a Cutting Plane *7.16*
7.18 Section Lines or Hatching *7.17*
7.19 Features Left Uncut *7.17*
7.20 Simplified Representation of Intersections *7.18*
7.21 Section Line Conventions *7.19*
7.22 Types of Sectional Views *7.20*
7.23 Revolved Section *7.22*
7.24 Removed Section *7.22*
7.25 Conventional Breaks *7.23*
7.26 Miscellaneous Problems *7.23*
Exercise 7B 7.24
7.27 Auxiliary Views *7.26*
7.28 Full and Partial Auxiliary Views *7.27*
7.29 Primary Auxiliary Views *7.27*
7.30 Secondary Auxiliary Views *7.29*
Exercise 7C 7.30
Review Questions 7.31
Multiple-Choice Questions 7.32

8. Projections of Points **8.1**
8.1 Introduction *8.1*
8.2 Location of a Point *8.1*
8.3 Conventional Representation *8.1*
8.4 Point above the H.P. and in Front of the V.P. *8.2*
8.5 Point above the H.P. and Behind the V.P. *8.3*
8.6 Point below the H.P. and Behind the V.P. *8.4*
8.7 Point below the H.P. and in Front of the V.P. *8.4*
8.8 Point on the H.P. and in Front of the V.P. *8.5*
8.9 Point above the H.P. and on the V.P. *8.6*
8.10 Point on the H.P. and Behind the V.P. *8.7*
8.11 Point below the H.P. and on the V.P. *8.7*
8.12 Point on both H.P. and V.P. *8.8*
8.13 Miscellaneous Problems *8.9*
Review Questions 8.10
Exercises 8.10
Multiple-Choice Questions 8.11

9. Projections of Straight Lines **9.1**

9.1 Introduction *9.1*
9.2 Orientations of Straight Lines *9.1*
9.3 Traces of Straight Lines *9.1*
9.4 Line Parallel to both H.P. and V.P. *9.2*
9.5 Line Perpendicular to H.P. *9.3*
9.6 Line Perpendicular to V.P. *9.4*
9.7 Line Inclined to H.P. and Parallel to V.P. *9.4*
9.8 Line Inclined to V.P. and Parallel to H.P. *9.5*
9.9 Line Situated in the H.P. *9.6*
9.10 Line Situated in the V.P. *9.7*
9.11 Line Situated both in H.P. and V.P. *9.8*
9.12 Summary *9.9*
9.13 Conclusions *9.10*
9.14 Miscellaneous Problems *9.10*
Exercise 9A *9.13*
9.15 Lines Inclined to both the Reference Planes *9.15*
9.16 Projections of a Line When True Length, True Inclination and Position of one end is Given *9.15*
9.17 To Determine the True Length and True Inclination of a Line When its Projections are Given *9.18*
9.18 Trapezoid Method to determine True Length and Inclinations *9.19*
9.19 To Determine the Traces of a Line Inclined to both the Reference Planes and $\theta + \phi \neq 90^\circ$ *9.20*
9.20 To Draw the Projections of a Line when it is Contained by a Profile Plane (i.e., $\theta + \phi = 90^\circ$) *9.22*
9.21 To Determine the Traces of a Line Contained by a Profile Plane *9.24*
9.22 Miscellaneous Problems *9.25*
Exercise 9B *9.46*
9.23 Projections of a Line when ends lie in Different Quadrants *9.49*
9.24 Miscellaneous Problems *9.51*
Review Questions *9.56*
Exercise 9C *9.57*
Multiple-Choice Questions *9.58*

10. Projections of Planes **10.1**

10.1 Introduction *10.1*
10.2 Orientations of Planes *10.1*
10.3 Plane is Parallel to H.P. *10.2*
10.4 Plane is Parallel to V.P. *10.3*
10.5 Plane is Perpendicular to both H.P. and V.P. *10.4*
10.6 Plane is Inclined to H.P. and Perpendicular to V.P. *10.4*
10.7 Plane is Inclined to V.P. and Perpendicular to H.P. *10.6*
10.8 Traces of Planes *10.8*
10.9 Summary *10.10*

10.10 Miscellaneous Problems *10.10*
Exercise 10A 10.13
10.11 Plane is Inclined to both the Reference Planes *10.15*
10.12 Plane Placed on an EDGE (or Diameter or Diagonal) Parallel to the H.P. such that the Surface is Inclined (at θ) to H.P. and that Edge is Inclined (at ϕ) to the V.P. *10.15*
10.13 Plane Rests on a Corner (or an end of Diameter or Diagonal) on the H.P. such that its Surface is Inclined (at θ) to H.P. and an Edge (which is Parallel to H.P.) is Inclined (at ϕ) to V.P. *10.16*
10.14 Plane is Inclined (at θ) to H.P. and an Edge or a Diagonal Already Inclined to H.P. is Inclined (at ϕ) to the V.P. *10.16*
10.15 Plane Rests on an Edge (or Diameter or Diagonal) on the V.P. such that the Surface is Inclined (at ϕ) to V.P. and that Edge is Inclined (at θ) to the H.P. *10.17*
10.16 Plane Rests on a Corner (or an end of Diameter or Diagonal) on the V.P. such that its Surface is Inclined (at ϕ) to V.P. and an Edge (Which is Parallel to V.P.) is Inclined (at θ) to H.P. *10.18*
10.17 Plane is Inclined (at ϕ) to V.P. and an Edge or a Diagonal Already Inclined to H.P. is Inclined (at θ) to the H.P. *10.19*
10.18 Plane is Inclined at an Angle θ to H.P. and at an Angle ϕ to V.P., such that $\theta + \phi = 90°$ *10.20*
10.19 Miscellaneous Problems *10.22*
Exercise 10B 10.26
10.20 Projections of Planes by Auxiliary Plane Method *10.28*
10.21 Projection of Planes on an Auxiliary Inclined Plane *10.28*
10.22 Projection of Planes on an Auxiliary Vertical Plane *10.29*
10.23 Miscellaneous Problems *10.30*
10.24 Application of Auxiliary Planes in Determining the True Shape and Size of the Plane *10.36*
Review Questions 10.38
Exercise 10C 10.38
Multiple-Choice Questions 10.39

11. Projections of Solids **11.1**
11.1 Introduction *11.1*
11.2 Classification of Solids *11.1*
11.3 Recommended Method for Naming the Corners of the Solids *11.4*
11.4 Orientations of Solids *11.5*
11.5 Axis Perpendicular to H.P. *11.5*
11.6 Axis Perpendicular to V.P. *11.7*
11.7 Axis Parallel to both H.P. and V.P. *11.8*
11.8 Miscellaneous Problems *11.9*
Exercise 11A 11.11
11.9 Rules of Visibility to know Visible and Hidden Edges *11.12*
11.10 Axis Inclined to H.P. and Parallel to V.P. *11.13*
11.11 Axis Inclined to V.P. and Parallel to H.P. *11.15*
11.12 Miscellaneous Problems *11.17*
Exercise 11B 11.27
11.13 Projections of Solids when Axis is Inclined to both the Planes *11.29*

11.14 Solid Rests on its Edge in the H.P. with its Axis Inclined (at θ) to H.P. and the Resting Edge is Inclined (at ϕ) to V.P. *11.29*
11.15 Solid Rests on its Corner in the H.P. (or Ground) with its Axis Inclined (at θ) to H.P. and Vertical Plane Containing the Axis and that Corner is Inclined (at ϕ) To V.P. *11.31*
11.16 Solid Rests on its Element (Corner or Edge) in the H.P. with its Axis Inclined (at θ) to H.P. and (at ϕ) to V.P. *11.32*
11.17 Solid Rests on an Edge of Base in V.P. (or Parallel to V.P.) with Axis Inclined (at ϕ) to V.P. and the Resting Edge Inclined (at θ) to H.P. *11.33*
11.18 Solid Rests on a Corner in the V.P. with its Axis Inclined (at θ) to V.P. and the Plane Containing the Axis and that Corner is Inclined (at ϕ) to H.P. *11.34*
11.19 Solid Rests on its Element (Corner or Edge) on the V.P. with its Axis Inclined (at θ) to H.P. and (at ϕ) to V.P. *11.35*
11.20 Miscellaneous Problems *11.36*
Exercise 11C *11.49*
11.21 Projections of Solids using Auxiliary Plane Method *11.51*
11.22 Projections of Solids on Auxiliary Inclined Plane *11.51*
11.23 Projections of Solids on Auxiliary Vertical Plane *11.52*
11.24 Projections of Spheres 11.58
Exercise 11D *11.63*
Review Questions *11.65*
Multiple-Choice Questions *11.65*

12. Sections of Solids **12.1**
12.1 Introduction *12.1*
12.2 Terminology *12.1*
12.3 Types of Section Planes *12.2*
12.4 Sections of Prisms *12.4*
12.5 Sections of Cylinders *12.9*
12.6 Miscellaneous Problems *12.13*
Exercise 12A *12.19*
12.7 Sections of Pyramids *12.20*
12.8 Sections of Cones *12.25*
12.9 Section of Spheres *12.29*
12.10 Section of Composite Solids *12.30*
12.11 Miscellaneous Problems *12.31*
Exercise 12B *12.35*
12.12 Anti-Sections *12.36*
Review Questions *12.53*
Exercise 12C *12.54*
Multiple-Choice Questions *12.56*

13. Development of Surfaces **13.1**
13.1 Introduction *13.1*
13.2 Classification of Surfaces *13.1*
13.3 Methods of Development *13.1*
13.4 Development of Prisms *13.2*

13.5 Development of Cylinders *13.4*
13.6 Development of Cones *13.6*
13.7 Development of Pyramids *13.9*
13.8 Development of Spheres *13.11*
13.9 Development of Transition Pieces *13.13*
13.10 Development of Tray *13.15*
13.11 Development of Oblique Objects *13.16*
13.12 Miscellaneous Problems *13.19*
Exercise 13A 13.36
13.13 Anti-Development *13.38*
Review Questions 13.48
Exercise 13B 13.48
Multiple-Choice Questions 13.49

14. Intersection of Surfaces **14.1**
14.1 Introduction *14.1*
14.2 Engineering Applications *14.1*
14.3 Methods of Determining the Curves of Intersection *14.1*
14.4 Types of Interpenetrating Solids *14.2*
14.5 Intersection of Prism by Another Solid *14.2*
14.6 Intersection of Cylinder by Another Solid *14.7*
14.7 Intersection of Pyramid by Another Solid *14.11*
14.8 Intersection of Cone by Another Solid *14.15*
14.9 When axes Intersect at an Angle other than Right Angles *14.21*
14.11 Intersection of Sphere by Another Solid *14.23*
14.11 Miscellaneous Problems *14.23*
Review Questions 14.26
Exercises 14.26
Multiple-Choice Questions 14.30

15. Isometric Projections **15.1**
15.1 Introduction *15.1*
15.2 Axonometric Projection *15.1*
15.3 Principle of Isometric Projection *15.2*
15.4 Terminology *15.3*
15.5 Construction of Isometric Scale *15.3*
15.6 Lines in an Isometric Projection *15.4*
15.7 Isometric Projections and Isometric views *15.4*
15.8 Dimensioning of Isometric Projection *15.5*
15.9 Isometric View of Planes *15.5*
Exercise 15A 15.10
15.10 Isometric View of Right Solids *15.10*
15.11 Isometric View of Solids Containing Non-Isometric Lines *15.11*
15.12 Isometric View of Truncated Solids *15.14*
15.13 Isometric View of Composite Solids *15.16*
15.14 Isometric View of Solids from Orthographic Views *15.18*
Review Questions 15.23

Exercise 15B *15.23*
Multiple-Choice Questions *15.26*

16. Oblique Projections **16.1**
16.1 Introduction *16.1*
16.2 Terminology *16.1*
16.3 Direction of Projectors *16.2*
16.4 Cavalier Projection *16.2*
16.5 Cabinet Projection *16.3*
16.6 General Oblique *16.3*
16.7 Rules for the Choice of Position of an Object *16.3*
16.8 Dimensioning Oblique Drawings *16.3*
16.9 Advantages of Oblique Drawing *16.4*
16.10 Oblique Projection of Planes *16.4*
16.11 Oblique Projections of Basic Solids *16.7*
16.12 Oblique Projections of Truncated Solids *16.10*
16.13 Oblique Projections of Composite and Hollow Solids *16.12*
16.14 Oblique Projections from Orthographic Views *16.12*
Review Questions *16.13*
Exercises *16.14*
Multiple-Choice Questions *16.15*

17. Perspective Projections **17.1**
17.1 Introduction *17.1*
17.2 Applications of Perspective *17.1*
17.3 Types of Perspective *17.1*
17.4 Characteristic Features *17.3*
17.5 Terminology used in Perspective Projection *17.3*
17.6 The Myth of Perspectives *17.4*
17.7 Methods of Drawing Perspective Views *17.4*
17.8 Miscellaneous Problems *17.16*
Review Questions *17.25*
Exercises *17.25*
Multiple-Choice Questions *17.27*

18. Computer Aided Design (CAD) **18.1**
18.1 Introduction *18.1*
18.2 CAD Application *18.1*
18.3 Software Providers *18.1*
18.4 Hardware and Operating System Technologies *18.2*
18.5 Basic Components of a Computer *18.2*
18.6 Introduction to AutoCAD *18.5*
18.7 Starting With AutoCAD 2007 *18.5*
18.8 AutoCAD Classic Workspace *18.5*
18.9 Setting up Drawing Space *18.7*
18.10 Sheet Layout *18.9*

18.11 MVSETUP Command *18.9*
18.12 command Execution *18.10*
18.13 Methods of Locating a Point *18.10*
18.14 Regulating the Cursor Movement *18.12*
18.15 Drawing Lines and Curves *18.13*
18.16 Editing a Drawing *18.26*
18.17 Miscellaneous Problems *18.39*
Review Questions *18.44*
Exercise *18.45*
Multiple-Choice Questions *18.47*

Index ***I.1***