

ELEMENTARY ENGINEERING DRAWING

TABLE OF CONTENTS

CHAPTER 1 DRAWING INSTRUMENTS AND THEIR USES 001-020			
1-1. Introduction	01	1-9. Drawing papers	13
1-2. Drawing board	02	1-10. Drawing pencils	13
1-3. T-square	02	1-11. Eraser (Rubber)	14
1-4. Set-squares	04	1-12. Drawing pins, Clips or adhesive tapes	14
1-5. Drawing instrument box	07	1-13. Sand-paper block	15
(1) Large-size compass with inter change eble pencil and pen legs	08	1-14. Duster	15
(2) Lengthening bar	08	1-15. Drafting machine	15
(3) Small bow compass	08	1-16. Roll-N-Draw	16
(4) Large-size divider	09	1-17. General suggestions for drawing a sheet	16
(5) Small bow divider	09	(1) Cleaning the instruments	16
(6) Small bow ink-pen	10	(2) Pinning the paper to the drawing board	16
(7) Inking pen	10	(3) Border lines	17
1-6. Scales	10	(4) Spacing of drawings	17
1-7. Protractor	12	Exercises I	18
1-8. French curves	12		
CHAPTER 2 SHEET LAYOUT AND FREE-HAND SKETCHING .. 021-032			
2-1. Sheet layout	21	(3) Schematic assembly drawing	26
(1) Sheet sizes, (2) Margin	21	(4) Drawing for instruction manual	26
(3) Borderlines, (4) Borders & frames	21	(5) Drawing for installation	26
(5) Orientation mark	21	(6) Drawing for catalogue	26
(6) Grid reference system	22	(7) Tabular drawing	26
(7) Title block	22	(8) Patent drawing	26
(8) List of parts or the bill of materials	23	2-3. Free-hand Sketching	26
(9) Revisions of drawing	23	(1) Sketching or freehand	26
(10) Folding marks	24	(2) Sketching materials	27
(11) Scales and scale drawing	25	(3) To sketch straight lines	27
2-2. Types of machine drawings	26	(4) To sketch circles and arcs	27
(1) Production drawing	26	(5) Sketching procedure	28
(2) Exploded assembly drawing	26	(6) Steps in sketching	28
		Exercises II	30
CHAPTER 3 LINES, LETTERING AND DIMENSIONING 033-050			
3-0. Introduction	33	(13) Cutting-plane lines	36
3-1. Lines	33	(14) Chain thick	36
(1) Line thickness	33	(15) Chain thick double-dots	36
(2) Inked drawings	33	3-2. Lettering	37
(3) Pencil drawings	33	(1) Single-stroke letters	37
3-1-1. Types of Lines	35	(2) Gothic letters	40
(1) Outlines	35	3-3. Dimensioning	40
(2) Margin lines	35	3-4. Dimensioning terms and notations	41
(3) Dimension lines	35	(1) Dimension line	41
(4) Extension or projection lines	35	(2) Extension line	41
(5) Construction lines	35	(3) Arrowhead, (4) Leader	41
(6) Hatching or section lines	35	3-5. Placing of dimensions	42
(7) Leader or pointer lines	35	(1) Aligned system	42
(8) Border lines	35	(2) Unidirectional system	42
(9) Short-break lines	35	3-6. Unit of dimensioning	43
(10) Long-break lines	35	3-7. General rules for dimensioning	43
(11) Hidden or dotted lines	35	3-8. Practical hints on dimensioning	43
(12) Centre lines	35	Exercises III	48

CHAPTER 4 SCALES 51-68

4-1. Introduction	51	(1) Plain scales	52
4-2. Scales	51	(2) Diagonal scales	55
(1) Engineer's, (2) Graphical scale	52	(3) Comparative scales	59
(3) Representative fraction ...	52	(4) Vernier scales	61
4-3. Scales on drawings	52	(5) Scale of chords	65
4-4. Types of scales	52	Exercises IV	66

CHAPTER 5 GEOMETRICAL CONSTRUCTION 69-100

5-0. Introduction	69	5-11. To construct squares	81
5-1. Bisecting a line	69	5-12. To construct regular polygons .	82
5-2. To draw perpendiculars	70	5-13. Special methods of drawing	
5-3. To draw parallel lines	72	regular polygons	84
5-4. To divide a line	73	5-14. Regular polygons inscribed	
5-5. To divide a circle	74	in circles	86
5-6. To bisect an angle	75	5-15. To draw regular figures using	
5-7. To trisect an angle	75	T-square and set-squares	88
5-8. To find the centre of an arc ..	76	5-16. To draw tangents	89
5-9. To construct an ogee or		5-17. Lengths of arcs	91
reverse curve	79	5-18. Circles and lines in contact ...	92
5-10. To construct equilateral		5-19. Inscribed circles	94
triangles	80	Exercises V	98

CHAPTER 6 CURVES USED IN ENGINEERING PRACTICE 101-150

6-0. Introduction	101	6-4. Evolutes	130
6-1. Conic sections	101	6-5. Spirals	133
6-1-1. Ellipse	102	6-5-1. Archimedean spiral	134
6-1-2. Parabola	109	6-5-2. Logarithmic or	
6-1-3. Hyperbola	112	equiangular spiral	136
6-1-4. Tangents and normals to conics	115	6-6. Helix	138
6-2. Cycloidal curves	116	6-6-1. A method of drawing a	
6-2-1. Cycloid	116	helical curve	138
6-2-2. Trochoid	118	6-6-2. Helical springs	139
6-2-3. Epicycloid and hypocycloid ...	120	6-6-3. Screw threads	141
6-2-4. Epitrochoid	122	6-6-4. Helix upon a cone	142
6-2-5. Hypotrochoid	123	6-7. Cam	143
6-3. Involute	124	Exercises VI	144

CHAPTER 7 LOCI OF POINTS 151-168

7-0. Introduction	151	(1) Simple slider crank mechanism	154
7-1. Loci of points	151	(2) Offset slider crank mechanism	154
7-2. Simple mechanisms	153	7-2-2. A four-bar mechanism	156
7-2-1. The slider crank mechanism ...	153	Exercises VII	166

CHAPTER 8 ORTHOGRAPHIC PROJECTION 169-188

8-0. Introduction	169	8-6. First-angle projection	171
8-1. Principle of projection	169	8-7. Third-angle projection	172
8-2. Methods of projection	169	8-8. Reference line	173
8-3. Orthographic projection	169	8-9. B.I.S. code of practice	177
8-4. Planes of projection	171	8-10. Typical Problems	177
8-5. Four quadrants	171	Exercises VIII	183

CHAPTER 9 PROJECTIONS OF POINTS 189-194

9-0. Introduction 189	9-3. A point is situated in the third quadrant 190
9-1. A point is situated in the first quadrant 189	9-4. A point is situated in the fourth quadrant 191
9-2. A point is situated in the second quadrant 190	9-5. General conclusions 191
	Exercises IX 193

CHAPTER 10 PROJECTIONS OF STRAIGHT LINES 195-240

10-0. Introduction 195	10-7. Line contained by a plane perpendicular to both the reference planes 205
10-1. Line parallel to one or both the planes 195	10-8. True length of a straight line and its inclinations with the reference planes 206
10-2. Line contained by one or both the planes 196	10-9. Traces of a line 209
10-3. Line perpendicular to one of the planes 197	10-10. Methods of determining traces of a line 211
10-4. Line inclined to one plane and parallel to the other 198	10-11. Traces of a line, the projections of which are perpendicular to xy 212
Exercises X(a) 200	10-12. Positions of traces of a line ... 212
10-5. Line inclined to both the planes 201	10-13. Additional illustrative problems 214
10-6. Projections of lines inclined to both the planes ... 203	Exercises X(b) 237

CHAPTER 11 PROJECTIONS ON AUXILIARY PLANES 241-254

11-0. Introduction 241	11-4. To determine true length of a line 247
11-1. Types of auxiliary planes and views 241	11-5. To obtain point-view of a line and edge-view of a plane 248
11-2. Projection of a point on an auxiliary plane 242	11-6. To determine true shape of a plane figure 250
11-3. Projections of lines and planes by the use of auxiliary planes . 246	Exercises XI 253

CHAPTER 12 PROJECTIONS OF PLANES 255-270

12-0. Introduction 255	(2) When the plane is parallel to the V.P. 259
12-1. Types of planes 255	12-5. Projections of planes inclined to one reference plane and perpendicular to the other 260
(1) Perpendicular planes 255	(1) Plane, inclined to the H.P. and perpendicular to the V.P. 260
(2) Oblique planes 257	(2) Plane, inclined to the V.P. & perpendicular to the H.P. 261
12-2. Traces of planes 257	12-6. Projections of oblique planes . 261
12-3. General conclusions	Exercises XII 269
(1) Traces 258	
(2) Projections 258	
12-4. Projections of planes parallel to one of the reference planes 259	
(1) When the plane is parallel to the H.P. 259	

CHAPTER 13 PROJECTIONS OF SOLIDS 271-312

13-0. Introduction 271	(2) Solids of revolution 273
13-1. Types of solids 271	13-2. Projections of solids in simple positions 274
(1) Polyhedra 271	Exercises XIII(i) 279

13-3.	Projections of solids with axes inclined to one of the reference planes and parallel to the other 279	13-4.	Projections of solids with axes inclined to both the H.P. and the V.P. 286
13-3-1.	Axis inclined to the V.P. and parallel to the H.P. 280	13-5.	Projections of spheres 300
13-3-2.	Axis inclined to the H.P. and parallel to the V.P. 282	(1)	Spheres in contact with each other 302
		(2)	Unequal spheres 303
			Exercises XIII(ii) 309

CHAPTER 14 SECTIONS OF SOLIDS 313-350

14-0.	Introduction 313	14-4.	Sections of cones 329
(1)	Section planes 313	(1)	Section plane parallel to the base of the cone 329
(2)	Sections 314	(2)	Section plane passing through the apex of the cone 330
(3)	True shape of a section . 314	(3)	Section plane inclined to the base of the cone at an angle smaller than the angle of inclination of the generators with the base 331
14-1.	Sections of prisms 314	(4)	Section plane parallel to a generator of the cone ... 333
(1)	Section plane parallel to the V.P. 314	(5)	Section plane inclined to the base of the cone at an angle greater than the angle of inclination of the generators with the base 334
(2)	Section plane parallel to the H.P. 315	14-5.	Sections of spheres 338
(3)	Section plane perpendicular to the H.P. and inclined to the V.P. 316	(1)	Section plane parallel to the H.P. 338
(4)	Section plane perpendicular to the V.P. and inclined to the H.P. 317	(2)	Section plane parallel to the V.P. 338
14-2.	Sections of pyramids 320	(3)	Section plane perpendicular to the V.P. and inclined to the H.P. 338
(1)	Section plane parallel to the base of the pyramid 321	(4)	Section plane perpendicular to the H.P. and inclined to the V.P. 339
(2)	Section plane parallel to the V.P. 321	14-6.	Typical Problems of Sections of Solids 340
(3)	Section plane perpendicular to the V.P. and inclined to the H.P. 322		Exercises XIV 347
(4)	Section plane perpendicular to the H.P. and inclined to the V.P. 323		
14-3.	Sections of cylinders 326		
(1)	Section plane parallel to the base 326		
(2)	Section plane parallel to the axis 326		
(3)	Section plane inclined to the base 326		

CHAPTER 15 DEVELOPMENT OF SURFACES 351-380

15-0.	Introduction 351	15-2-1.	Cube 352
15-1.	Methods of development 352	15-2-2.	Prisms 354
(1)	Parallel-line development 352	15-2-3.	Cylinders 356
(2)	Radial-line development . 352	15-2-4.	Pyramids 360
(3)	Triangulation development 352	15-2-5.	Cone 365
(4)	Approximate method 352	15-3.	Development of transition pieces 372
15-2.	Developments of lateral surfaces of right solids 352	15-4.	Spheres 376
			Exercises XV 377

CHAPTER 16 INTERSECTION OF SURFACES 381-416	
16-0. Introduction	381
16-1. Line of intersection	381
16-2. Methods of determining the line of intersection between surfaces of two interpenetrating solids	382
(1) Line method	382
(2) Cutting-plane method	382
16-3. Intersection of two prisms	382
16-4. Intersection of cylinder and cylinder	390
16-5. Intersection of cylinder & prism	396
16-6. Intersection of cone & cylinder	401
16-7. Intersection of cone & prism	409
16-8. Intersection of cone and cone	411
16-9. Intersection of sphere and cylinder or prism	412
Exercises XVI	414
CHAPTER 17 ISOMETRIC PROJECTION 417-464	
17-1. Introduction	417
17-2. Isometric axes, lines & planes	418
17-3. Isometric scale	418
17-4. Isometric drawing or isometric view	420
17-5. Isometric graph	420
17-6. Illustrative problems	421
17-6-1. Isometric drawing of planes or plane figures	421
17-6-2. Isometric drawing of prisms and pyramids	425
17-6-3. Isometric drawing of cylinders	429
17-6-4. Isometric drawing of cones	429
17-6-5. Isometric drawing of sphere	430
17-7. Typical problems of isometric drawing	431
Exercises XVII	445
Solutions to Exercises XVII	454
CHAPTER 18 OBLIQUE PROJECTION 465-476	
18-1. Introduction	465
18-2. Principle of the oblique projection	465
18-3. The oblique projection and the isometric projection	466
18-4. Receding lines & receding angles	467
18-5. Types of the oblique projection	467
18-6. Rules for the choice of position of an object	468
18-7. Steps for drawing the oblique projection	469
18-8. Oblique drawing of pyramid	470
18-9. Oblique drawing of circle	470
(1) Offset method	470
(2) Four centre approximate method	471
18-10. Oblique drawing of cylinder	471
18-11. Oblique drawing of prism	472
18-12. Typical problems of oblique projection	474
Exercises XVIII	475
CHAPTER 19 PERSPECTIVE PROJECTION 477-510	
19-1. Introduction	477
19-2. Principle of perspective projection	477
19-3. Definitions of perspective elements	477
(1) Ground plane	478
(2) Station point	478
(3) Picture plane	478
(4) Horizontal plane	478
(5) Auxiliary ground plane	478
(6) Ground line (7) Horizon line	478
(8) Perpendicular axis	478
(9) Centre of vision	478
(10) Central plane	478
19-4. Station point	479
19-5. Angle of vision	479
19-6. Picture plane	480
19-7. Methods of drawing perspective view	480
19-7-1. Visual-ray method	481
19-7-2. Vanishing-point method	485
19-8. Types of perspective	486
(1) Parallel perspective or one point perspective	486
(2) Angular perspective or two point perspective	487
(3) Oblique perspective or three point perspective	488
19-9. Distance points	489
19-10. Measuring line or line of heights	491
19-11. Perspectives of circles & solids	492
19-12. Typical problems of perspective projection	494
(1) Visual-ray method – by means of the top view and the front view	494
(2) Visual-ray method – by means of the top view and the side view	494
(3) Vanishing-point method	494
Exercises XIX	509

CHAPTER 20 ORTHOGRAPHIC READING AND CONVERSION OF VIEWS 511-538

- | | | | |
|---|-----|--|-----|
| 20-1. Introduction | 511 | 20-5. Conversion of pictorial views
into orthographic views | 517 |
| 20-2. Reading of orthographic views
(Blue-print reading) | 511 | 20-6. Orthographic projection | 517 |
| 20-3. Missing lines and
missing views | 512 | 20-7. Procedure for preparing a
scale-drawing | 522 |
| 20-4. Identification of planes | 512 | 20-8. Illustrative problems | 523 |
| | | Exercises XX | 526 |

CHAPTER 21 CENTRES OF GRAVITY AND MOMENTS OF INERTIA OF AREAS 539-554

- | | | | |
|---|-----|--|-----|
| 21-0. Introduction | 539 | 21-2. Moments of inertia of areas . | 547 |
| 21-1. Centre of gravity | 539 | (1) Definition | 547 |
| 21-1-1. Centres of gravity of
symmetrical areas | 539 | (2) Unit | 547 |
| 21-1-2. Centres of gravity of
unsymmetrical areas | 540 | (3) Graphical method | 548 |
| 21-1-3. Illustrative problems on
centre of gravity | 541 | 21-3. Illustrative problems on
moments of inertia | 548 |
| | | Exercises XXI | 553 |

CHAPTER 22 NOMOGRAPHY 555-572

- | | | | |
|---|-----|---|-----|
| 22-0. Introduction | 555 | 22-4. Method of constructing parallel
scale nomographs | 559 |
| 22-1. Types of nomographs | 555 | 22-5. Layout of nomographs | 563 |
| 22-2. Definitions of various terms . | 556 | 22-6. Z-type nomographs | 568 |
| 22-3. Principle of construction of
nomographs of three variables | 557 | Exercises XXII | 571 |

CHAPTER 23 SCREW THREADS 573-584

- | | | | |
|---------------------------------------|-----|---|-----|
| 23-0. Introduction | 573 | (4) British Standard Fine
and British Standard
Pipe threads | 576 |
| 23-1. Definitions | 573 | (5) Sellers thread | 577 |
| (1) Crest, (2) Root, (3) Flank | 573 | (6) British Association thread | 578 |
| (4) Angle, (5) Depth | 573 | 23-2-2. Square thread | 578 |
| (6) Nominal diameter | 573 | (1) Acme thread | 578 |
| (7) Outside or major diameter | 573 | (2) Knuckle thread | 578 |
| (8) Core or minor diameter . | 573 | (3) Buttress thread | 578 |
| (9) Effective diameter | 574 | 23-3. Conventional representation
of threads SP: 46-2003 | 579 |
| (10) Pitch, (11) Lead, (12) Slope | 574 | 23-4. Multiple-start threads | 581 |
| 23-2. Forms of screw threads | 574 | 23-5. Right-hand & left-hand threads | 582 |
| 23-2-1. Triangular or V threads | 575 | Exercises XXIII | 583 |
| (1) Unified thread | 575 | | |
| (2) Metric thread | 576 | | |
| (3) Whitworth thread | 576 | | |

CHAPTER 24 SCREWED FASTENINGS 585-606

- | | | | |
|---|-----|---|-----|
| 24-0. Introduction | 585 | 24-4. Bolts | 590 |
| 24-1. Types of nuts | 585 | 24-5. Forms of bolts | 590 |
| 24-1-1. Hexagonal nut | 586 | (1) Hexagonal-headed bolt . | 590 |
| 24-1-2. Square nut | 588 | (2) Square-headed bolt | 592 |
| 24-2. Types of nuts for special purpose | 589 | (3) Cylindrical or cheese-
headed bolt | 593 |
| (1) Flanged nut | 589 | (4) Cup-headed or round-
headed bolt | 593 |
| (2) Cap nut, (3) Dome nut . | 589 | (5) T-headed bolt | 594 |
| (4) Cylindrical or capstan nut | 589 | (6) Countersunk-headed bolt | 594 |
| (5) Ring nut, (6) Wing nut . | 590 | | |
| 24-3. Washers | 590 | | |

(7) Hook bolt	594	(7) Penn, ring or grooved nut	600
(8) Headless tapered bolt ..	594	(8) Stop-plate or locking-plate	601
(9) Eye-bolt	595	(9) Spring-washer	601
(10) Lifting eye-bolt	595	24-8. Foundation bolts	602
(11) Tap-bolt or cap-screw .	595	(1) Eye or Hoop bolt	602
(12) Stud-bolt or stud	595	(2) Rag bolt, (3) Lewis bolt .	602
24-6. Set-screws	597	(4) Cotter bolt	603
24-7. Locking arrangements for nuts	598	(5) Curved or bent bolt	603
(1) Lock-nut or check-nut ..	598	(6) Squar-headed bolt	604
(2) Split-pin	599	24-9. Spanner	604
(3) Slotted nut	599	24-10. Longitudinal or bar stay	604
(4) Castle nut	600	24-11. Conventional symbols	
(5) Sawn nut or Wiles nut ..	600	for nuts and bolts	605
(6) Simmond's lock-nut	600	Exercises XXIV	605

CHAPTER 25 RIVETED JOINTS AND WELDED JOINTS 607-620

25-1. Introduction	607	25-7-1. Connection of plates	
25-2. Riveting	607	at right angles	614
25-2-1. Caulking and fullering	608	25-7-2. Gusset stay	614
25-3. Forms and proportions		25-8. Welded joints	615
of rivet-heads	608	25-8-1. Welding	615
25-4. Failure of riveted joints	609	25-8-2. Types of welding process	615
25-5. Dimensions of a		25-8-3. Types of welded and	
riveted joint	609	welds joints	616
25-6. Types of riveted joints	610	(1) Types of welded joints ..	616
25-6-1. Lap joint	610	(2) Types of welds	616
25-6-2. Butt joint	611	25-8-4. Representation of welded joints	617
25-7. Rolled-steel sections	613	Exercises XXV	619

CHAPTER 26 COMPUTER AIDED DRAFTING (CADr) 621-702

26-1. Introduction	621	26-5-5. Drafting Aids	630
26-2. Computer Aided Drafting	621	26-5-6. Editing of a Drawing	632
26-3. Computer	622	26-6. Symbol Library	634
26-3-1. Processor (CPU)	623	26-7. Two dimensional drawings ...	634
26-3-2. Display	623	26-8. Isometric drawings	659
26-3-3. INPUT Devices	624	26-9. 3d Geometrical Modeling ...	665
26-3-4. Graphic Output Devices	625	26-9-1. 3d Wireframe Modelling	666
26-4. CAD Software	625	26-9-2. 3d Surface Modelling	669
26-5. AutoCAD	626	26-9-3. 3d Solid Modelling	680
26-5-1. Hardware required for		26-9-4. Commands To Generate	
AutoCAD 2009/2010	627	Profile Based 3d Solids	682
26-5-2. Classic screen layout of		26-10. Three Dimensional Drawings .	686
AutoCAD 2010	627	26-11. Perspective View In AutoCAD	700
26-5-3. Function keys	628	Exercises XXVI	701
26-5-4. Drawing Entities	628		

INDEX 703-708