	PREFACE		XIII	
	INTR	ODUCTION	1	
1		ERING, NOTATION,		
	AND	LINEWORK	2	
	1.1	Descriptive Geometry	3	
	1.2	Notation and Labeling	4	
	1.3	Line and Symbol Key	5	
	1.4	Notation Key	6	
	1.5	Notation	6	
	1.6	Linework	7	
	1.7	Pencil and Lead Selection	7	
	1.8	Linework and Technique	7	
	1.9	Instrument Drawings	8	
	1.10		8	
	1.11	Erasing/Keeping the Drawing Clean	8	
	1.12	_ · · · · · · · ·	9	
	1.13		9	
	1.14		9	
	1.15		13	
	1.16		13	
	1.17		13	
	1.18		13	
		Scales and Descriptive Geometry	13	
		Problem Page Setup	14	
	1.21	Problem Specifications	14	
2	GEON	IETRIC CONSTRUCTION	15	
	2.1	Geometric Constructions	16	
	2.2	Curved Lines	16	

The Bow Compass and Dividers

2.3

	2.4	The French Curve	18
	2.5	Lines	19
	2.6	Construction of Parallel	
		and Perpendicular Lines	19
	2.7	Angles and Circles	20
	2.8	Dividing a Line into Equal Parts	21
	2.9	Vertical Method	22
	2.10	Proportional Division of a Line	22
	2.11	Bisectors for Lines and Angles	23
	2.12	7.6	24
	2.13	2 -, 8	25
	2.14		
		of a Known Circle	26
	2.15	Construction of a Circle Through Three	
		Given Points	26
	2.16	good y or a Limb and the	27
	2.17	A Line Tangent to a Circle	
		Through a Point	27
	2.18	Tangent Arcs	28
	2.19		29
	2.20		29
	2.21	To Rectify the Circumference	
		of a Circle	30
	2.22	The Approximate Rectification	
		of an Arc	30
	2.23	Ellipse Construction	31
		Geometric Forms, Polyhedra	33
		Curved Surfaces	34
	2.26	Warped Surfaces	35
3	PROJ	ECTION	36
	3.1	Projection	37
	3.2	Multiview Projection	38
	3.3	Orthographic Projection	39

Orthographic Projection

39

	3.4	The Six Principal Views	40
	3.5	First and Third Angle Projection	41
	3.6	The Glass Box and Fold Lines	42
	3.7	Line of Sight	43
	3.8	Auxiliary Views	44
	3.9	Primary Auxiliary Views	45
	3.10	Frontal Auxiliary Views	46
	3.11	Horizontal Auxiliary Views	47
	3.12	Profile Auxiliary Views	48
	3.13	Auxiliary View Applications	49
	3.14	Secondary Auxiliary Views	50
	3.15	Related/Adjacent Views	51
4	POIN	TS AND LINES	57
	4,1	Points and Lines	50
	4.2	Views of Points	58
	4.3	Rectangular Coordinates of a Point	59
	4.4	Primary Auxiliary Views of a Point	60
	4.5	Secondary Auxiliary Views of a Point	61
	4.6	Lines	62
	4.7		64
	4.8	Orthographic Projection of a Line Auxiliary Views of Lines	65
	4.9	Principal Lines	66
	4.10	Definitions	67
	4.11	Level and Vertical Lines	67
	4.12		68
		Frontal Lines	69 71
		Horizontal Lines	71 72
	4.15	Profile Lines	72 73
	4.16		73 74
	4.17		74 75
	4.18	True Length of a Line	75 76
	4.19	True Length Diagrams	70 77
	4.20	Point View of a Line	77 78
	4.21	Points on Lines	80
	4.22	Point on Line by Spatial Description	00
	1.22	and Coordinate Dimension	81
	4.23	Typical Characteristics of Two Lines	82
	4.24	Visibility of Lines	83
		Visibility of Lines and Surfaces	
	4.26	Skew Lines	84 85
	4.27		86
	4.28		87
	4.29	B	89
	4.30	Parallel and Nonparallel Lines	09
		(Special Cases)	90
	4.31	Construction of a Line Parallel	90
		to a Given Line	91
	4.32	Perpendicularity of Lines	93
	4.33	Intersecting Perpendicular Lines	94
	4.34	Nonintersecting Perpendicular Lines	95
	4.35	Construction of a Line Perpendicular)5
	-	to a Given Oblique Line	96
	4.36	Line Drawn Perpendicular to a Given	70
	-	Line at a Specific Point	97
	4.37	Shortest Distance between a Point	,,
		and a Line (Line Method)	99
	4.38	Shortest Distance between a Point	,,
		and a Line (Plane Method)	100
	4.39	Shortest Distance between Two Skew	100
		Lines	101

	4.40	Shortest Distance between Two Skew	
	4.40		102
	4 4 1	Lines (Plane Method)	102
	4.41	Shortest Horizontal (Level) Distance	104
	4.42	between Two Skew Lines	104
	4.42	Steepest Connection between a Point	105
	4 42	and a Line	103
	4.43	Shortest connector between Two Lines	106
	4 4 4	and through a Given Point	100
	4.44	Connector between a Point and a Line	107
	4.45	at a Specified Angle	107
	4.45	Angle between Two Intersecting Lines	110
	4.46	Angle between Two Skew Lines	110
	4.47	Angle between a Line and a Principal	111
	4.40	Plane	111
	4.48	Bearing of a Line	
	4.49		114
	4.50	Slope of a Line	115
	4.51	Grade of a Line	116
	4.52	Slope Designations	117
	4.53	To Draw a Line Given the True Length,	110
		Bearing, and Slope (Grade)	118
	4.54	Shortest Line of a Given Slope	110
		(or Grade) between Two Skew Lines	119
	4.55	Revolution/Rotation	121
	4.56		122
	4.57		122
		Axis	123
	4.58	Revolution of a Line	124
	4.59	True Length of Line in Horizontal	125
		View by Revolution	125
	4.60	True Length of a Line by Revolution	126
	4.61	Slope of a Line by Revolution	127
	4.62	Revolution of a Line about an Oblique	120
		Axis	128
	4.63	Revolution of a Line	129
		about a Horizontal Line (Axis)	131
	4.64	Cone Locus of a Line	131
	4.65	Construction of a Line at Given Angles	132
		to Two Principal Planes	132
	4.66	Locus of a Line at Given Angles	133
		with Two Principal Planes	133
E	DIAN	re	136
5	PLAN	E9	150
	<i>.</i> .	Discore	137
	5.1	Planes	138
	5.2	Representation of Planes	138 139
	5.3	Principal Planes	140
	5.4	Vertical Planes	140 141
	5.5	Oblique and Inclined Planes	141
	5.6	Auxiliary Views of a Plane	143 144
	5.7	Points on Planes	144 145
	5.8	Lines on Planes	143 146
	5.9	True Length Lines on Planes	140
	5.10	Locating Parallel and Nonparallel Lines	147
		on Planes	147
	5.11	Edge View of a Plane	149
	5.12	Edge View of Plane by Primary	150
	_	Auxiliary View	150 151
	5.13	True Size (Shape) of Oblique Plane	151 152
	5.14	Views of Circular Planes	152 153
	5.15	Plane Figures on a Given Plane	155 154
	5.16	Circles on Planes	134

5.17		155
5.18	Strike of a Plane	157
5.19	Slope of a Plane	158
5.20	Visibility	160
5.21	Parallelism of Lines and Planes	161
5.22		162
5.23	Plane through a Point Parallel	
	to a Given Plane	163
5.24	Perpendicularity of Planes	165
5.25	Line Perpendicular to a Plane (Edge	
	View Method)	166
5.26	Line Perpendicular to a Plane (Two	
	View Method)	167
5.27	Plane Perpendicular to a Line	
	and through a Given Point	168
5.28	Plane through a Given Line	
	Perpendicular to a Plane	169
5.29	Plane through a Point	
	and Perpendicular to Two Given Planes	170
5.30	Shortest Distance between a Point	
	and a Plane	172
5.31	Shortest Grade or Slope Line	
	between a Point and a Plane	173
5.32	Angle between a Line and a Plane	
	(Plane Method)	174
5.33	Angle between a Line and a Plane	
	(Line Method)	175
5.34	Angle between a Line and a Plane	
	(Complementary Angle Method)	176
5.35	Angle between a Plane and a Principal	
	Projection Plane	177
5.36	Angle between Two Planes	179
5.37	Angle between Planes (Dihedral Angle)	180
5.38	Angle between Two Limited Planes	
	without a Common Intersection Line	181
5.39	Revolution of Planes	183
5.40	Edge View of Plane Using Revolution	184
5.41	True Size of a Plane by Revolution	185
5.42	True Shape of a Plane Using Revolution	186
5.43	Double Revolution of a Plane	187
5.44	True Size of a Plane by Double	
	Revolution	188
5.45	Angle between a Line and a Plane	
	by Revolution	190
5.46	Angle between Two Planes	
	by Revolution	191
5.47	Dihedral Angle by Revolution	192
5.48	Revolution of Planes at Specified	
	Angles	194
5.49	Revolution of a Plane about a Given	
	Line	195
5.50	Restricted Revolution and Clearance	196
5.51	Revolution of a Solid	197
5.52	Double Revolution of a Solid	198
5.53	Piercing Points (Edge View Method)	200
5.54	Piercing Point of a Line and a Plane	•
	(Edge View Method)	201
5.55	Piercing Points (Cutting Plane Method)	202
5.56	Piercing Point of a Line and a Plane	-
	(Individual Line Method)	203
5.57	Piercing Point by Line Extension (Edge	
	View Method)	204

Projection of a Point on a Plane

206

5.58

	5.59	Projection of a Line on a Plane (Cutting Plane Method)	207
	5.60	Projection of a Line on a Plane (Edge	
		View Method)	208
6	INTE	RSECTIONS	211
	6.1	Intersections	212
	6.2	Intersection of Two Planes (Edge View Method)	213
	6.3	Intersection of Two Oblique Planes (Edge View Method)	214
	6.4	Intersection of Two Planes (Cutting Plane Method)	215
	6.5	Intersection of Planes (Cutting Plane Method)	216
	6.6	Intersection of Two Infinite Planes	
		(Cutting Plane Method)	217
	6.7 6.8	Intersection of a Line and a Prism Intersection of a Plane and a Right	219
		Prism (Edge View Method)	220
	6.9	Intersection of a Plane and an Oblique	
	(10	Prism (Edge View Method)	221
	6.10	Intersection of an Oblique Plane and an Oblique Prism (Edge View	
		Method)	222
	6.11	Intersection of a Plane and a Right	222
		Prism (Cutting Plane Method)	223
	6.12	Intersection of an Oblique Plane	
		and an Oblique Prism (Cutting View	
	6.13	Method) Intersection of a Plane and a Pyramid	224
	0.15	(Edge View Method)	226
	6.14	Intersection of a Plane and a Pyramid	220
		(Cutting Plane Method)	227
	6.15	Cylinders	228
	6.16	Oblique Cylinders	229
	6.17 6.18	Intersection of a Line and a Cylinder Intersection of a Plane and a Cylinder	230
	6.19	Intersection of a Plane and a Cynnder Intersection of an Oblique Plane	231
		and an Oblique Cylinder (Edge View	
		Method)	232
	6.20	Intersection of an Oblique Plane	
		and an Oblique Cylinder (Cutting Plane	
	6.21	Method)	233
	6.22	Cones Intersection of a Line and a Cone	235
	6.23	Intersection of a Line and an Oblique	236
		Cone	237
	6.24	Conic Sections (Intersection of a Plane	
	6.25	and a Cone)	238
	6.26	Intersection of a Plane and a Cone Intersection of an Oblique Plane	239
	0.20	and a Cone (Cutting Plane Method)	240
	6.27	Spheres	240 242
	6.28	Intersection of a Line and a Sphere	243
	6.29	Intersection of a Plane and a Sphere	244
	6.30	Intersection of a Plane and a Torus	245
	6.31	Intersection of Prisms	247
	6.32	Intersection of Two Prisms (Edge View Method)	240
	6.33	Intersection of Two Prisms (Cutting	248

Plane Method)

249

	6.34	Intersection of a Prism and a Pyramid	251	
	6.35	,		
		(Edge View Method)	252	
	6.36			
		(Cutting Plane Method)	253	
	6.37		255	
	6.38			
		Right Angles)	256	
	6.39		257	
	6.40		258	
	6.41	Intersection of a Cylinder and a Prism		
		(Edge View Method)	259	
	6.42	Intersection of Cones	261	
	6.43			
		Cones	262	
	6.44		263	
	6.45			
		Cylinder	264	
	6.46		265	
	6.47			
	C 40	Cylinder	267	
	6.48	Intersection of an Oblique Cone	260	
	(40	and a Cylinder	268	
	6.49	Intersection of an Oblique Cone	260	
	6.50	and an Oblique Cylinder	269	
	6.51	Intersection of a Cone and a Prism	270	
	6.52	<u>-</u>	272	
	6.53	Pictorial Intersections	273	
	6.54	Pictorial Intersections Pictorial Intersection of a Line	275	
	0.54	and a Plane	276	
	6.55	Pictorial Intersection of Two Planes	277	
			279	
	6.57		217	
	0.57	and a Solid	280	
	6.58	Pictorial Intersection of a Plane	200	
		and a Solid Object	281	
	6.59	One-Point Perspective (Pictorial		
		Intersection)	284	
	6.60	Fair Surfaces	286	
	6.61	Fairing	287	
7	DEVE	LOPMENTS	291	
-			271	
	7.1	Developments	292	1
	7.2	Basic Developments	293	
	7.3	Types of Developments	294	
	7.4	Sheet Metal Developments	295	
	7.5	Development of Models	297	
	7.6	Development of a Right Prism	298	
	7.7	Development of a Truncated		
		Right Prism	299	
	7.8	Development of a Truncated		
		and Cutout Right Prism	300	
	7.9	Development of an Oblique Prism	302	
	7.10	Development of a Prism (Top Face		
		and Lower Base Included)	303	
	7.11	Development of an Intersected Prism	304	
	7.12	Development of a Right Pyramid	306	
	7.13	Development of a Truncated Right		
		Pyramid	<i>307</i>	
	7.14	Development of a Truncated Right		
		Pyramid (Top Face Included)	308	

7.15	Development of an Oblique Pyramid	309
7.16	True Length Diagrams	312
7.17	Development of a Truncated Oblique	
	Pyramid	313
7.18	Curved Surfaces	315
7.19	- 0	
7.00	Surfaces	316
7.20	Development of a Right Circular	
7.21	Cylinder Davidonment of a Truncated Bight	317
1.21	Development of a Truncated Right Circular Cylinder	210
7.22	Development of an Oblique Cylinder	318 320
7.23	Development of Intersecting Cylinders	320 322
7.24	Development of an Elbow Joint	323
7.25	Development of Cones	325
7.26	Development of a Right Circular Cone	326
7.27	Development of a Truncated Right	
	Circular Cone	327
7.28	Development of an Oblique Cone	329
7.29	Development of a Truncated Oblique	
7.20	Cone	330
7.30 7.31	Development of a Conical Offset Development of an Oblique Cone	331
7.31	without Using the Vertex	222
7.32	Transition Pieces	332 334
7.33	Development of Transition Pieces	335
7.34	Triangulation	336
7.35	Development of a Transition Piece	
	by Triangulation	337
7.36	Development of a Transition Piece:	
	Circular to Rectangular	338
7.37	Transition Piece Development	339
7.38	Development of a Convolute Transition	240
7.39	Piece Development of a Warped Transition	340
1.39	Piece	341
7.40	Double-Curved Surfaces	343
7.41	Spheres	344
7.42	Development of a Sphere (Gore	
	Method)	345
7.43	Development of a Sphere (Zone	
	Method)	346
	NO AND CEOLOGY	353
MIINI	NG AND GEOLOGY	300
0.1		25.
8.1	Mining and Topographic Applications	354 255
8.2 8.3	Contour Maps and Plan-Profiles Plan-Profiles and Vertical Sections	355 356
8.4	Bearing, Slope, and Grade of a Line	350 357
8.5	Plan-Profile of a Pipeline	35 <i>7</i> 359
8.6	Cut and Fill for a Level Road	361
8.7	Cut and Fill for a Grade Road	362
8.8	Cut and Fill for a Roadway and a Dam	363
8.9	Cut and Fill for a Curved Roadway	
	and a Dam	364
8.10	Mining Applications	367
8.11	Mining and Geology Terms	368
8.12	Strike, Dip, and Thickness of an Ore Vein	369
8.13	Strike, Dip, and Outcrop	507
5.15	of an Ore Vein	370
8.14	Outcrop and Distances to Ore Vein	371

	8.15		
	8.16	(Mineral Strata)	373
	0.10	Line of Intersection between Two Ore Veins	374
	8.17		3 /4
	0.17	Overlapping Ore Veins	375
9	WAR	PED SURFACES	377
	0.1	Wormed Courfesses	
	9.1 9.2	Warped Surfaces	378
	9.3	Cow's Horn and Warped Cone The Conoid	379
	9.3 9.4	The Colloid The Cylindroid	380
	9.5	Hyperbolic Paraboloids	382 383
	9.6	Hyperboloid of Revolution	384
10	THE	HELIX	386
		Helices	387
	10.2	_	388
	10.3	The Oblique Helicoid	389
11	TANG	ENCIES	391
	*		371
	11.1	Tangencies	392
	11.2	Plane Tangent to a Cone	393
	11.3	Plane Tangent to a Sphere	394
	11.4	Plane Tangent to a Convolute	395

12	SHAD	ES AND SHADOWS	397
	12.1		398
		Shades and Shadows: Cylinders	399
	12.3	Shades and Shadows: Cones	
		and Pyramids	400
	12.4	Oblique Pictorial Shade and Shadow	401
	12.5	Isometric Pictorial: Shade and Shadow	402
13	VECT	ORS AND GRAPHICAL STATICS	403
	I	Vector Representations of Forces	
		for Graphical Solutions and Statics	
		Problems	405
	13.1	Definition of Terms	406
	13.2		406
	13.3	Definitions of Diagrams	407
	13.4	Necessary Conditions for Expected	
		Results	407
	13.5	e-p vocci ballimation	408
	II	- I	411
	13.6	Two Forces Acting on an Object	411
	13.7	Three Forces at a Pin Collection	413
	13.8	Three Forces Acting on a Beam	416
	13.9	Three Parallel Forces Acting on a Beam	419
	13.10	Four or More Forces Acting	
		on a Beam	421
	13.11		424
	III	Planar I oldo Dybtollib	430
		The Special Case	432
	13.13	The General Case	436
IND	EX		441