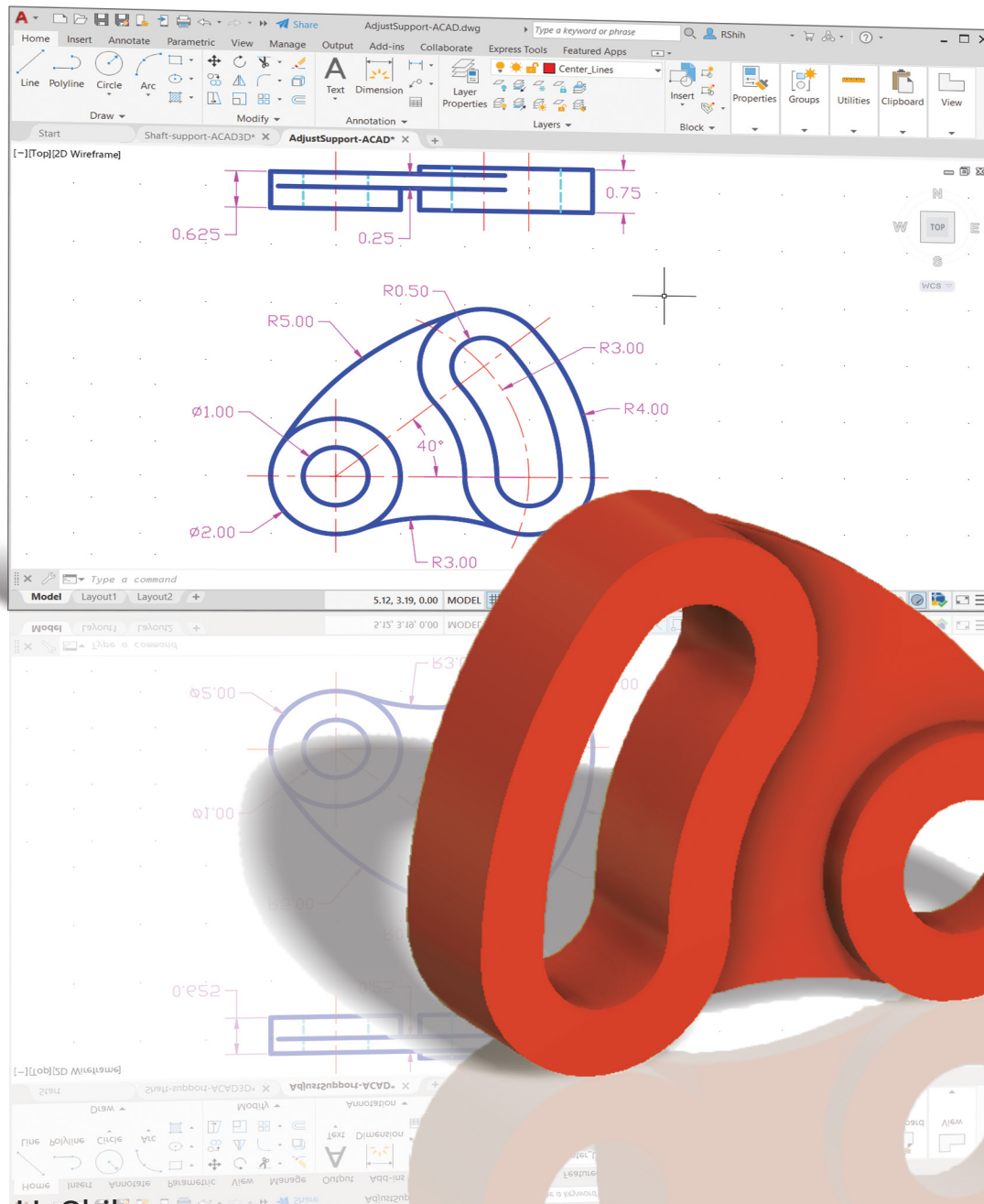


# Principles and Practice

An Integrated Approach to Engineering Graphics and AutoCAD® 2022



Randy H. Shih

Visit the following websites to learn more about this book:



[amazon.com](https://www.amazon.com)

[Google books](https://books.google.com)

[BARNES & NOBLE](https://www.barnesandnoble.com)

# Table of Contents

Preface	i
Acknowledgments	ii
Table of Contents	iii
AutoCAD Certified User Examination Reference Guide	xiii
Tips on Taking the AutoCAD Certified User Examination	xx

## Chapter 1

### Introduction and AutoCAD Fundamentals

Introduction	1-3
Drawing in CAD Systems	1-5
Development of Computer Geometric Modeling	1-5
Why use AutoCAD 2022?	1-8
Getting Started with AutoCAD 2022	1-10
AutoCAD 2022 Screen Layout	1-11
Application Menu	1-12
Quick Access Toolbar	1-12
AutoCAD Menu Bar	1-12
Layout Tabs	1-12
Drawing Area	1-13
Graphics Cursor or Crosshairs	1-13
Command Prompt Area	1-13
Cursor Coordinates	1-13
Status Toolbar	1-13
Ribbon Tabs and Panels	1-14
Draw and Modify Toolbar Panels	1-14
Layers Control Toolbar Panel	1-14
Viewport/View/Display Controls	1-14
Mouse Buttons	1-15
[Esc] - Canceling Commands	1-15
Online Help	1-16
Leaving AutoCAD 2022	1-17
Creating a CAD File Folder	1-17
Drawing in AutoCAD	1-18
Starting Up AutoCAD 2022	1-18
Drawing Units Setup	1-20
Drawing Area Setup	1-21
Drawing Lines with the Line Command	1-23
Visual Reference	1-25
Grid On	1-26
Snap Mode On	1-27
Using the Erase Command	1-28
Repeat the Last Command	1-29

The CAD Database and the User Coordinate System	1-30
Changing to the 2D UCS Icon Display	1-31
Cartesian and Polar Coordinate Systems	1-32
Absolute and Relative Coordinates	1-32
Defining Positions	1-33
GRID Style Setup	1-33
The Guide Plate	1-34
Creating Circles	1-38
Saving the CAD Design	1-40
Close the Current Drawing	1-41
The Spacer Design	1-42
Start a New Drawing	1-42
Drawing Units Setup	1-43
Drawing Area Setup	1-44
Use the Line Command	1-46
Use the Erase Command	1-48
Using the Arc Command	1-48
Using the Circle Command	1-50
Saving the CAD Design	1-51
Exit AutoCAD 2022	1-51
Review Questions	1-52
Exercises	1-53

## Chapter 2

### Geometric Constructions

Geometric Constructions	2-3
Geometric Constructions - Classical Methods	2-4
Bisection of a Line or Arc	2-4
Bisection of an Angle	2-5
Transfer of an Angle	2-6
Dividing a Given Line into a Number of Equal Parts	2-7
Circle through Three Points	2-8
Line Tangent to a circle from a Given Point	2-9
Circle of a Given Radius Tangent to Two Given Lines	2-10
Circle of a Given Radius Tangent to an Arc and a Line	2-11
Circle of a Given Radius Tangent to Two Arcs	2-12
Starting Up AutoCAD 2022	2-13
Dynamic Input	2-13
Object Snap Toolbar	2-17
Geometric Construction - CAD Method	2-18
Bisection of a Line or Arc	2-18
Bisection of an Angle	2-21
Transfer of an Angle	2-23
Dividing a Given Line into a Number of Equal Parts	2-27
Circle through Three Points	2-29

---

Line Tangent to a Circle from a Given Point	2-30
Circle of a Given Radius Tangent to Two Given Lines	2-31
The RockerArm Design	2-34
Activate the Startup Option	2-34
Drawing Units Display Setup	2-36
GRID and SNAP Intervals Setup	2-36
Drawing Area Setup	2-37
Referencing the World Coordinate System	2-38
Creating Circles	2-39
Object Snap Toolbar	2-40
Using the Line Command	2-41
Creating TTR Circles	2-43
Using the Trim Command	2-45
Using the Polygon Command	2-47
Creating a Concentric Circle	2-49
Using the QuickCalc Calculator to Measure Distance and Angle	2-50
Saving the CAD File	2-54
Exit AutoCAD	2-54
AutoCAD Quick Keys	2-55
Review Questions	2-56
Exercises	2-57

### Chapter 3

## Object Properties and Organization

Introduction	3-3
The Floor Plan Design	3-3
Starting Up AutoCAD 2022	3-4
Using the Setup Wizard	3-4
Drawing Units Setup	3-5
Reference Area Setup	3-5
Grid and Snap Intervals Setup	3-6
Using the Zoom Extents Command in the Navigation Bar	3-7
The AutoCAD Multiline Command	3-7
Object Snap Toolbar	3-10
Drawing Multilines	3-11
Creating Interior Walls	3-14
Joining the Walls Using Multiline Edit	3-17
Using Layers and Object Properties	3-19
Using the Zoom Realtime Option	3-22
Modeling the Bathroom	3-23
Controlling Layer Visibility	3-25
Adding a New Layer	3-25
Moving Objects to a Different Layer	3-26
Matching Layer Properties	3-27
Review Questions	3-29

Exercises	3-30
-----------	------

## Chapter 4

### Orthographic Projection and Multiview Constructions

Introduction	4-3
Basic Principles of Projection	4-4
Orthographic Projection	4-4
Multiview Orthographic Projection	4-5
First-Angle Projection	4-6
Rotation of the Horizontal and Profile Planes	4-7
Getting the 3D Adjuster Model through the Internet	4-8
Dynamic Rotation – 3D Orbit	4-9
General Procedure: 1 <sup>st</sup> Angle Orthographic Projection	4-10
1 <sup>st</sup> Angle Orthographic Sketching Exercises	4-11
Third-Angle Projection	4-13
Rotation of the Horizontal and Profile Planes	4-14
Examining the 3 <sup>rd</sup> Angle Projection	4-15
The Glass Box and the Six Principal Views	4-16
Examining the Glass Box Model	4-18
General Procedure: 3 <sup>rd</sup> Angle Orthographic Projection	4-19
Example 2: 3 <sup>rd</sup> Angle Orthographic Projection	4-20
3 <sup>rd</sup> Angle Orthographic Sketching Exercises	4-21
Alphabet of Lines	4-23
Precedence of Lines	4-25
The Locator Part	4-26
Starting Up AutoCAD 2022	4-26
Layers Setup	4-27
Drawing Construction Lines	4-28
Using the Offset Command	4-28
Set Layer Object as the Current Layer	4-30
Using the Running Object Snaps	4-30
Creating Object Lines	4-32
Turn Off the Construction Lines Layer	4-33
Adding More Objects in the Front View	4-33
AutoCAD's AutoSnap™ and AutoTrack™ Features	4-34
Adding More Objects in the Top View	4-36
Drawing Using the Miter Line Method	4-40
More Layers Setup	4-42
Top View to Side View Projection	4-43
Completing the Front View	4-45
Object Information Using the List Command	4-47
Object Information Using the Properties Command	4-48
Review Questions	4-49
Exercises	4-50

**Chapter 5****Pictorials and Sketching**

Engineering Drawings, Pictorials and Sketching	5-2
Isometric Sketching	5-7
Isometric Sketching Exercises	5-9
Oblique Sketching	5-19
Oblique Sketching Exercises	5-20
Perspective Sketching	5-26
One-point Perspective	5-27
Two-point Perspective	5-28
Perspective Sketching Exercises	5-29
Review Questions	5-35
Exercises	5-36

**Chapter 6****AutoCAD 2D Isometric Drawings**

Introduction	6-2
The Angle Support Design	6-3
Starting Up AutoCAD 2022	6-4
AutoCAD Isoplane and Isodraft Commands	6-5
Layers Setup	6-6
Create the Base Box of the Design	6-7
Create the Design inside the Base Box	6-11
Create the Isocircle on the top face	6-14
Using the Editing Tools in an Isometric drawing	6-17
The Tube Anchor Design – Modeling Strategy	6-17
Start a New Drawing and Layers Setup	6-18
Create a Base Box of the Design	6-19
Locate the Centers for the Isocircles	6-22
Create the Isocircles	6-24
Using the Parametric tools to complete the drawing	6-31
Review Questions	6-36
Exercises	6-37

**Chapter 7****Dimensioning and Notes**

Introduction	7-3
Dimensioning Standards and Basic Terminology	7-4
Selection and Placement of Dimensions and Notes	7-5
Metric Dimensioning versus English Dimensioning	7-12
Machined Holes	7-13
Baseline and Chain Dimensioning	7-16
Dimensioning and Tolerance Accumulation	7-17

(1) Tolerance Accumulation – Baseline Dimensioning	7-18
(2) Tolerance Accumulation – Chain Dimensioning	7-19
(3) Avoid Tolerance Accumulation – Dimensioning Features	7-20
Dimensioning Tools in AutoCAD	7-21
The P-Bracket Design	7-21
Starting Up AutoCAD 2022	7-22
Layers Setup	7-23
The P-Bracket Design	7-24
LineWeight Display Control	7-24
Drawing Construction Lines	7-25
Using the Offset Command	7-25
Set Layer Object_Lines as the Current Layer	7-27
Creating Object Lines	7-27
Creating Hidden Lines	7-28
Creating Center Lines	7-29
Turn Off the Construction Lines	7-29
Using the Fillet Command	7-30
Saving the Completed CAD Design	7-31
Accessing the Dimensioning Commands	7-32
The Dimension Toolbar	7-33
Using Dimension Style Manager	7-33
Dimensions Nomenclature and Basics	7-34
Using the Center Mark Command	7-37
Adding Linear Dimensions	7-38
Adding an Angular Dimension	7-39
Adding Radius and Diameter Dimensions	7-40
Using the Multiline Text Command	7-41
Adding Special Characters	7-42
Saving the Design	7-43
A Special Note on Layers Containing Dimensions	7-43
Review Questions	7-44
Exercises	7-45

## **Chapter 8**

### **Tolerancing and Fits**

Precision and Tolerance	8-2
Methods of Specifying Tolerances – English System	8-3
Nomenclature	8-4
Example 7.1	8-5
Fits between Mating Parts	8-6
Selective Assembly	8-7
Basic Hole and Basic Shaft Systems	8-7
American National Standard Limits and Fits – Inches	8-8
Example 7.2 Basic Hole System	8-13
Example 7.3 Basic Hole System	8-14



Example 7.4 Basic Shaft System	8-15
Example 7.5 Basic Shaft System	8-16
Tolerancing – Metric System	8-17
Metric Tolerances and Fits Designation	8-18
Preferred ISO Metric Fits	8-19
Example 7.6 Metric Hole Basis System	8-20
Example 7.7 Shaft Basis System	8-21
Updating the Bracket Drawing	8-22
The Dimension Style Manager	8-22
Tolerances Settings in the Dimension Style Manager	8-23
Determining the Tolerances Required	8-24
Review Questions	8-28
Exercises	8-29

## Chapter 9

### **Symmetrical Features in Designs**

Introduction	9-3
The GenevaCam Design	9-3
Starting Up AutoCAD 2022	9-4
Setting Up the Plot Style Mode	9-5
Starting a New File	9-7
Grid and Snap Intervals Setup	9-8
Layers Setup	9-9
Adding Borders and Title Block in the Layout	9-10
Create a Template File	9-13
Exit AutoCAD 2022	9-14
Starting Up AutoCAD 2022	9-14
The Geneva Cam Drawing	9-15
Drawing Construction Lines	9-16
Creating Object Lines	9-17
Using the Offset Command	9-18
Using the Mirror Command	9-20
Using the Array Command	9-21
Creating a Viewport Inside the Title Block	9-24
Viewport Properties	9-25
Hide the Viewport Borders	9-26
Adjusting the Dimension Scale	9-26
Plot/Print the Drawing – Color or Grey Scale Prints	9-28
Create a B size Layout of the design	9-30
Adjust the Dimension Scale for the B size Print	9-34
Additional Title Blocks	9-36
Review Questions	9-38
Exercises	9-39

**Chapter 10****Auxiliary Views**

Introduction	10-3
Normal View of an Inclined Surface	10-4
Construction Method I – Folding Line Method	10-6
Construction Method II – Reference Plane Method	10-8
Partial Views	10-10
Creating Auxiliary Views in AutoCAD	10-11
The V-Block Design	10-11
Starting Up AutoCAD 2022	10-12
Setting Up the Principal Views	10-13
Setting Up the Top View	10-16
Using the Offset Command	10-17
Creating Object Lines in the Front View	10-19
Setting the Polar Tracking Option	10-20
Setting Up an Auxiliary View	10-23
Aligning the Auxiliary View to the Front View	10-24
Creating the V-cut in the Auxiliary View	10-24
Creating the V-cut in the Front View and Top View	10-27
Setting the Polar Tracking Option	10-29
Completing the Top View	10-29
Edit the Plot Style Table – Black and White Prints	10-32
Start a new drawing for a Metric Template File	10-35
Layers Setup	10-36
Set up Metric Borders and Title Block by Copy & Paste	10-37
Review Questions	10-42
Exercises	10-43

**Chapter 11****Section Views**

Introduction	11-3
General Rules of Section Views	11-5
Section Drawing Types	11-6
Full Section	11-6
Half Section	11-6
Offset Section	11-7
Broken-Out Section	11-7
Aligned Section	11-8
Half Views	11-8
Thin Sections	11-8
Revolved Section	11-9
Removed Section	11-9
Conventional Breaks	11-10
Ribs and Webs in Sections	11-10
Parts Not Sectioned	11-10

Section Views in AutoCAD	11-11
The Bearing Design	11-11
Starting Up AutoCAD 2022	11-12
The Bearing Design	11-13
Setting up the Principal Views	11-13
Creating Object Lines in the Front View	11-15
Editing the Circles	11-17
Setting Up the Side View	11-18
Adding Hidden Lines in the Side View	11-20
Changing the Linetype Scale Property	11-22
Stretching and Moving Objects with Grips	11-23
Drawing a Cutting Plane Line	11-24
Converting the Side View into a Section View	11-27
Adding Section Lines	11-29
Review Questions	11-32
Exercises	11-33

## Chapter 12

### Threads and Fasteners

Introduction	12-2
Screw-Thread Terminology	12-3
Thread Forms	12-5
Thread Representations	12-6
Detailed Representation	12-7
Schematic Representation	12-8
Simplified Representation	12-9
Thread Specification – English Units	12-10
Unified Thread Series	12-11
Thread Fits	12-12
Thread Specification – Metric	12-12
Thread Notes Examples	12-13
Specifying Fasteners	12-14
Commonly used Fasteners	12-15
Drawing Standard Bolts	12-17
Bolt and Screw Clearances	12-17
Review Questions	12-18
Exercises	12-19

## Chapter 13

### Working Drawings

General Engineering Design Process	13-3
Working Drawings	13-4
Detail Drawings	13-4
Assembly Drawings	13-5

Bill of Materials (BOM) and Parts List	13-5
Drawing Sizes	13-6
Drawing Sheet Borders and Revisions Block	13-6
Title Blocks	13-7
Working Drawings with AutoCAD	13-8
The Shaft Support Subassembly	13-9
Additional Parts	13-9
Cap-Screw	13-9
Collar	13-10
Base-Plate	13-10
Starting Up AutoCAD and Loading Multiple Drawings	13-11
Using AutoCAD with the Internet	13-12
Rearrange the Displayed Windows	13-13
Defining a Block	13-14
Insert and Rotate a Block	13-16
Starting the Assembly Drawing	13-17
Copying and Pasting with the Windows Clipboard	13-18
Converting the View into a Section View	13-19
Adding the Bearing to the Assembly	13-21
Adding the Cap-Screws to the Assembly	13-24
Creating Callouts with the Multileader Command	13-26
Creating a Viewport in the A-size Layout	13-29
Viewport Properties	13-30
Adding a Parts List to the Assembly Drawing	13-31
Review Questions	13-37
Exercises	13-38

## **Appendix**

- A. Running and Sliding Fits – American National Standard
- B. Metric Limits and Fits
- C. Unified National Thread Form
- D. Metric Thread Form
- E. Fasteners (Inch Series)
- F. Metric Fasteners
- G. Bolt and Screw Clearance Holes
- H. References

## **Index**