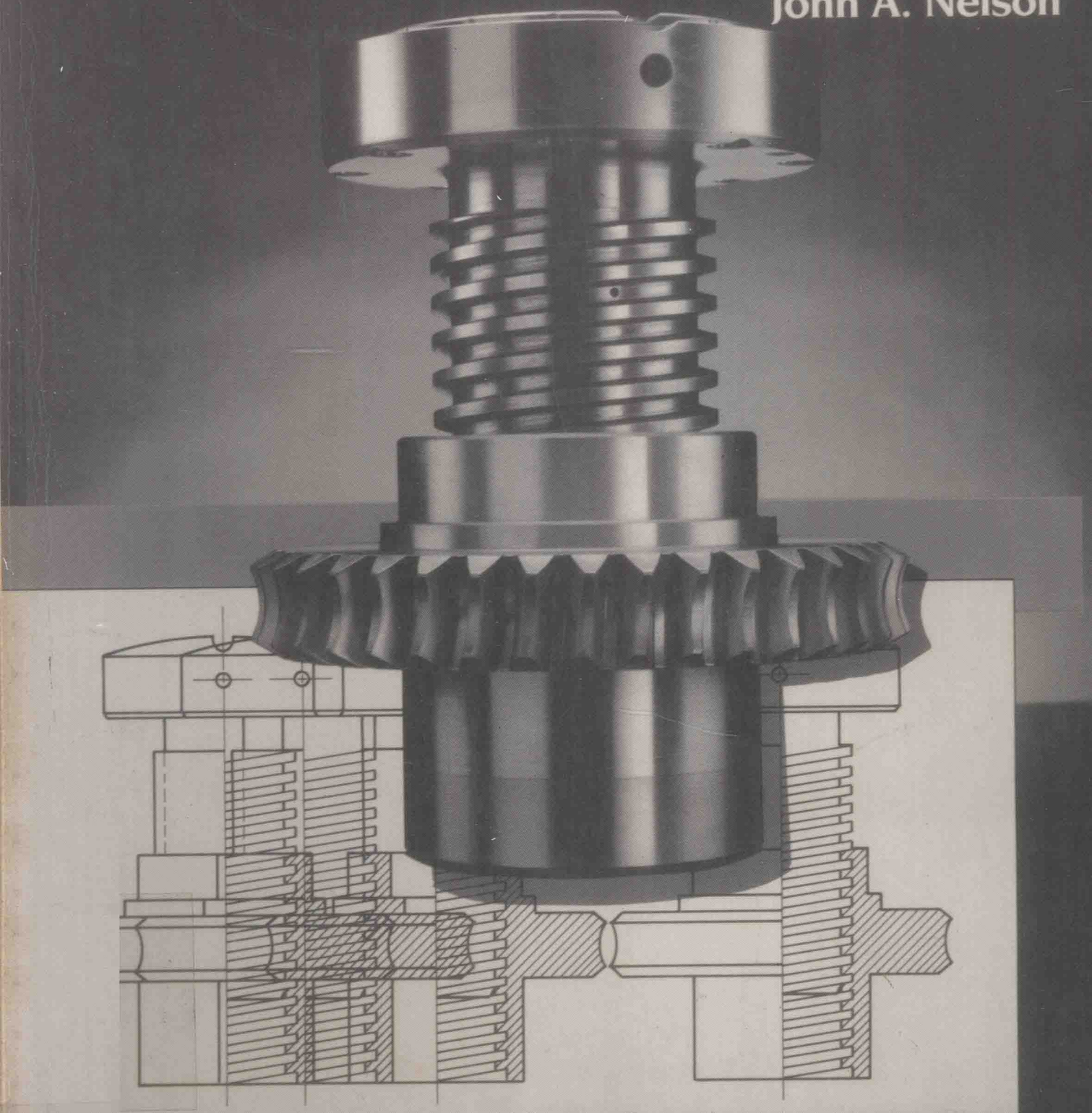
Instructor's Guide

TECHNICAL DRAWING AND DESIGN

David L. Goetsch
John A. Nelson



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CONTENTS

ANSWERS TO REVIEW QUESTIONS

Introduction

1. A graphic representation of an idea, a concept, or an entity which actually or potentially exists in life.

2. One picture is worth a thousand words.

3. Artistic and technical.

4. Artistic drawings express the feelings, beliefs, philosophies, or abstract ideas of the artist. Technical drawings clearly and concisely communicate all of the information necessary to transform an idea or concept into reality.

5. a) The object; b) The eye of the viewer; c) The imaginary projective plane; and d) Lines of sight or projectors.

6. Orthographic, oblique, and axonometric.

7. Isometric, dimetric, and trimetric.

8. One, two, and three point.

9. ...Identification of the problem
   ...Initial ideas
   ...Selection of a proposed solution
   ...Development and testing of models or prototypes
   ...Development of working drawings

10. Manufacturing, engineering, architecture, and construction.

11. Technical drawings guide the collective efforts of all persons involved in converting an idea into reality. Artistic drawings convey emotions for the purpose of individual expression.

12. ANSI, DOD, and MIL.

Chapter 1

1. 9H, 8H, 7H, 6H, 5H, 4H, 3H, 2H, H, F, HB, B, 2B, 3B, 4B, 5B, 6B, 7B.
   Two recommended for drafting are: 4H and 2H.

2. The translucent paper with coated print paper is passed under a bright light which burns coating off print paper and leaves outline of drawing. The print paper is passed through ammonia vapor and developed.

3. 1. 30°-60° Triangle 2. 45° triangle 3. Adjustable triangle

4. See paragraph on micrometer reading.

5. To ensure accuracy and quality of drawing.

6. T-square, parallel-straightedge, drafting machine. The drafting machine is best because it increases accuracy and reduces time.

7. 8½ x 11 inches; 9 x 12 inches; A-4 of 210 x 297 millimetres.

8. Full divided - the basic units are subdivided throughout length of scale.
   Open divided - only the end unit is subdivided.

9. Spring-bow type because it retains its setting when pressure is used to draw dark lines.

10. Keeps drawings clean, avoiding smearing and expedite drafting process. It should be removed to avoid sticking to rollers of white whiteprinter.

11. To keep drawing surface clean.

12. Read protractor first to get the degrees (20°), then read the vernier to get minute (10') which lines up with protractor. It is used to produce angles.

13. 1-98 3'-6"
    1-99 4'-8"
    1-100 5'-9"
    1-101 2'-7"
    1-102 4'-3"
    1-103 3'-9½"
    1-104 1'-7"
    1-105 1'-6½"
    1-106 1'-9¼"
    1-107 0'-6½"
    1-108 3.60"
    1-109 1"=10=23.00', 1"=100=230.00', 1"=1000=2,300.00'
    1-110 1"=40=40.00', 1"=400=400.00', 1"=4,000=4,000.00'
    1-111 56 mm

Chapter 2

1. Single-stroke Gothic.

2. 2 unit incline for 5 units of height.

3. Neatness, uniformity, stability, proper spacing, and speed.

4. Three

5. ¼"

6. Width of a round letter.

7. 2H, H, or HB (any two)

8. Light lines made to help drafters make uniform letters.

9. Uniformity and readability.

10. ¼"

    8/32"=1/4"

11. All the various techniques used in creating graphic data.

12. Visible, hidden, dimension, extension, center, phantom, cutting plane, sectioning, stitch, and leader.

13. a. Requires little material support.
    b. Can be done almost anywhere.

14. Top, front, right side, left side, bottom, and back.

15. Isometric

16. Axonometric

Chapter 3

1. Right Angle: ∠ of 90°
   Acute Angle: ∠ less than 90°
   Obtuse Angle: ∠ greater than 90°

2. Triangle, square, hexagon, octagon, pentagon, and trapezoid.

3. Help simplify drawing tasks, produce accurate drawings, in fastest time possible and prevent wasted motions.

4. The term means to "touch." Accuracy of object will increase if all tangent points are found before darkening in drawing.

5. Central Angle: Formed by two radial lines from the circle's center.
   Sector: Area of a circle between two radial lines and the circumference.
   Quadrant: A sector with central angle of 90°, and one radial line oriented horizontally.
   Segment: Smaller portion of a circle separated by a chord.

6. Concentric - Two or more circles with a common center point.
   Eccentric - Two or more circles without a common center point.

7. By the crossing of two lines, their intersection being the point.

8. An angle is formed by the intersection of two lines.

9. Equilateral, isosceles, scalene, obtuse, right triangle.

10. It is the distance around the outer surface of the circle.
    The formula used to calculate it is: π x DIA

11. 180°

12. A line is the distance between two points, being either straight, arc circle or free curve.

Chapter 4

1. To aid in selection of best front view and its best position. It helps eliminate errors in finished drawing and selection of views and their positions.

2. Runout - curved surfaces formed where a flat and curved surface meet.
   Rounds - are rounded exterior corners.
   Fillets - are interior rounded corners.

3. A perspective view is a pictorial drawing in which receding lines converge at vanishing points on the horizon. A multiview drawing is a flat, two-dimensional drawing of an object from multiple directions.

4. The work area is the center of the paper within its borders.

5. Third-angle projection is used in the United States and Canada. First-angle projection is used in most of the rest of the world.

6. .06 deep

7. To establish a third-angle projection view.

8. A 30°-60° triangle is used.

9. The front view is the most important view. It should show the most basic shape in profile. It should be drawn so that it is shown in a stable position. It should be placed in such a position that the other views have as few hidden edges as possible. It should show the most detail. (Any three)

10. Usually no more than two or three views.

11. A 45° triangle is used.

12. Numbers are added to various features of complicated drawings to make them easier to visualize, and to ensure that the final drawing is correct.

13. The "S" break -- used for round objects
The "Z" break -- used for thin, long or wide parts
The freehand break -- used to illustrate long, rectangular parts

14. An incomplete view is used when the left- and right-side views are difficult to understand because they overlap.

15. Center horizontally by adding horizontal distance of views and the 1" space between views. Subtract this from the total work area. The remaining space is then equally divided between edge views. To center vertically, the same procedure is followed.

Chapter 5

1. Conventional - uses multiview or orthographic method of representation.
True projection - uses sectioning to show the interior of an object which otherwise cannot be shown.

2. A revolved section is a rotated section that is placed on the object itself.
A removed section is a section that is removed from the object.
A removed section is recommended today.

3. Yes. To clarify the drawing and when their use will make it possible to omit a view.

4. To illustrate and/or dimension a small feature.

5. Full section, offset section, half section, broken-out section, revolved section, removed section, auxiliary section, thinwall section, and assembly section.

6. Alternate section lining is where the length is alternated which produces double spaced section lines in part of the sectioned object. It is used in some cases to distinguish a ribbed section from an adjacent open space.

7. 1. To show how various parts go together.
2. To show detail parts in their functional positions.

8. They are not drawn as a true projection.

9. Half-section

10. A cross-reference should be given to the page the removed section is located on.

11. 1. Long dimension - the fastener or shaft is not sectioned.
    2. Perpendicular - section lining is added to fastener or shaft.

12. Identification of individual parts.
    Balloon call-out system and parts list.

Chapter 6

1. Shows true size of a surface.
   Shows true shape of a surface including angles and arcs.

   It is used to project and complete other views.

2. Front auxiliary view, top auxiliary view, and side auxiliary view.

3. Rounded view must be divided into (preferably) 12 equal parts and each point lettered clockwise.

4. Used to eliminate one or more regular views.

5. Should be omitted unless needed for clarity.

6. Placed such that the auxiliary view is projected 90° from the inclined surface of regular view.

7. Drawn at right angles to the projection lines between the views.

8. Must be drawn at 90°.

9. Used on symmetrical views when space is limited. Such use could save time, but is used only as a last resort.

10. An auxiliary view in section.

11. Used when primary auxiliary view will not fully illustrate the object. When used it is projected from the primary auxiliary view.

Chapter 7

1. a. Find the distance from fold line to points.
   b. Project these points to necessary view.
   c. Transfer corresponding distances from necessary view.
   d. Connect necessary lines.

2. To find solutions to problems dealing with points, lines, planes, and their relationship in space.

3. Notations are labelings used to progress through sequential steps and keep track of views and points in space.

4. The end view of a line.

5. 1. Project to a view to show true length of lines.
   2. Project to a view to show point view of lines.

3. The straight line path between their endpoints is the true distance between the parallel lines.

6. 1. Project the true length of either one of the two lines and the other into that auxiliary view.
   2. Find the point view of the true length line and project other line into secondary auxiliary view.

7. The point view of a true length line of a plane.

8. It is called-out in lower case letters.

9. Always skip a view between all measurements.

10. 1. Draw a fold line parallel to the line that the true length is required of.
    2. Label fold line.
    3. Extend projection lines from end points of the line being projected into the auxiliary view.
    4. Transfer end point distances from the fold line in second preceding view from the one being drawn.

11. It indicates a 90° intersection.

12. 1. Draw fold line perpendicular to the true length line.
    2. Label fold line.
    3. Extend a light projection line from the true length line into secondary auxiliary view.
    4. Transfer the distance of the line end points into the secondary auxiliary view.

Chapter 8

1. A transitional piece connects two differently shaped, differently sized or skewed position openings. Triangulation would be used for development of pattern.

2. Sharp V or rounded V.

3. The actual thickness of sheet metal.

4. 90°

5. Then all fold lines and other markings are related directly to inside measurements. Also, they are convenient for use in fabricating shop.

6. Parallel line, radial line, triangulation.

7. To fasten the edges in the development of a truncated prism.

8. Bend allowance is the length of material of the neutral axis within the material where neither compression or stretching occurs. Used to compensate for lost length due to bend.

9. 1. Divide top and bottom surfaces into equal spaces.
   2. Connect necessary points, adding dashed lines to segment object into various triangles.
   3. True distances are found.

10. A time saving device used to develop true lengths and distances of an object's boundary edges.

11. It is being phased out because of the confusion caused by the system. The system has different gages used for different materials and for wire.

12. True lengths and true distances of the object's boundary edges must be determined.

Chapter 9

1. ANSI Y14.5M-1982
2. 15.05
3. Decimal-inch
4. 0.9
5. Horizontal
6. Extension lines, dimension lines, arrowheads, leader lines, and dimensions.
7. 1/3"
8. 3:1
9. Uniformity
10. All dimensions are placed horizontally.
11. Brief carefully worded statements placed on drawings to convey information not covered or not adequately explained using graphics.
12. Directly above the title block.
13. Horizontally
14. Broad items of information which have job or project wide applications.
15. ¼"
16. Having notes double checked by experienced drafters.
17. Even lines give notes an appearance of balance. This makes notes easier to read and more attractive.

Chapter 10

1. Computer models replace actual models and prototypes.
2. Documentation of the design process.
3. Using computers and peripheral devices to document the design process.
4. Computer-aided drafting
   Automated drafting
   Computer-aided design and drafting
   Computer-aided engineering
   Computer graphics
   Computer-aided manufacturing
5. Tools and techniques
6. The graphics display, text display, keyboard, digitizer, light pen or puck, function menu, and plotter.

7. On magnetic tapes or disks.

8. Hardware, software, and users.

9. A graphics display, text display, keyboard, digitizer, menu, plotter, and a processor.

10. Refresh, raster, and storage tube.

11. Alphanumeric and auxiliary.

12. Cathode ray tube

13. Cursor control, for mounting menus, and digitizing graphic data.

14. Compilation of system commands, options, and stored data.

15. Screen menus and tablet menus.

16. Pen, electrostatic, and photoplotters.

17. The computer. Memory and logic components.

18. Operational, application, and user.

19. More accurate
    Faster
    Neater
    More consistent
    Better for correcting, revising, and storing

20. Positively for those who learn CAD.

Chapter 11

1. Input, manipulation, and output.

2. Keying, digitizing, cursor control, entering system commands, and activating menu options.

3. Entering text on drawings, entering system commands, entering dimensions, and logging-on to the system.

4. Cross-hair symbol on the graphics display.

5. Thumbwheels, trackball, joystick, light pen, and puck.

6. DRAW LINE, DRAW CIRCLE, DRAW RECTANGLE, ENTER TEXT, ADD DIMENSION

7. Screen menu, tablet menu, or keyboard menu.

8. Text and graphic.

9. Solid lines, arcs, rectangles, circles, squares, ellipses. and triangles.

10. A special sequenced code which gives users access to a CAD system.

Chapter 12

1. Setting acceptable limits of deviation.

2. Unilateral and bilateral.

3. The need to tolerance more than just the size of objects.

4. A dimensioning practice which allows designers to set tolerance limits not just for the size of an object, but for all of the various critical characteristics of a part.

5. ANSI Y14.5M-1982

6. a. 
   b. 
   c. 
   d. 
   e. 
   f. 
   g. 

7. Most material exists

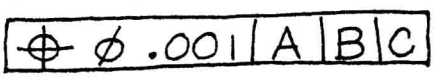
8. The tolerance applies regardless of the actual produced size of the part.

9. Least material exists.

10. a reference point or plane.

11. High point contact.

12. Specific point contact.

13. 

14. Flatness, straightness, circularity, and cylindricity.

15. Angularity, parallelism, perpendicularity, profile, runout, and true position.

Chapter 13

1. 1. Adjusting parts
   2. Transmitting power

2. #5100-800

3. 1. Adequate clearance to install ring.
   2. Must ring take up accumulated tolerances?
   3. Possiblity of machining ring groove on shaft or inside bore.
   4. Adjustability of ring on shaft.

4. 5/8 major DIA, 11 T.P.I., Unified form - Course series, Class of fit(2) External thread, 2½ inches long.

5. See table.

6. The end will travel ½ inch.

7. Self-locking rings

8. 3/8-UNC-2A x 3LG Round head

9. See table.

10. ½ inch

11. See table.

12. The distance between the crest and root of the thread measured at right angle to the axis.

Chapter 14

1. 1. Time saving technique
   2. Cost saving technique

2. 1. Plain open end
   2. Plain closed end
   3. Ground open end
   4. Ground closed end (the most stable)

3. Both dimensions are not necessary when other regular dimensions are given. The more important or controlling dimension should be given.

4. Material, number of coils (active and inactive) direction of winding, torque data (torsion spring), finish, heat treatment spec; any other required data.

5. Helical spring and flat spring.

6. 3.00

7. 1. Compression spring 
   2. Extention spring 
   3. Torsion spring 

8. The section lining of the coils would be filled in solid.

9. Overall length of spring in its free state of unloaded condition.

10. 1. Used as clamps on automobile hoses.
    2. Used to return a door knob back to its original position.
    3. Used as a spring on a latch such as a suitcase.

Chapter 15

1. 1. Raise and lower the valve in an automobile engine
   2. Feed machanisms
   3. Printing presses

2. The speed of rotation and load applied upon the lifters.

3. 1. Radial design - which changes a rotary motion into either an up and down motion or a rocking action.
   2. Cylindrical design - the rotation of the shaft is the same as the radial design, but the follower operates parallel to the shaft.

4. A distance equal to the distance from the center of the cam shaft to the highest point on the cam.

5. A curve showing the displacement of the follower as ordinates erected on a base line that represents one revolution of the cam. The speed and various positions are thus planned.

6. Length - is equal in length to the circumference of the working circle.
   Height - is equal to the radius of a working circle.

7. 1. Uniform velocity
   2. Modified uniform velocity
   3. Harmonic motion being smoothest of the four
   4. Uniform acceleration

8. A cam follower which is on another center line than that of the cam.

9. It is used to show the relationship between two or more cams to each other when placed on same shaft.

10. Because in a stationary position the true rotative effect is obtained by allowing the follower to rotate about the cam in the opposite direction.

Chapter 16

1. $D_o = D + 2a$
   $D_o = 1.5 + 2a$
   $D_o = 1.5 + .0625$
   $\boxed{D_o = 1.5625}$

   $a = \frac{1}{P}$
   $a = \frac{1}{32}$
   $a = .03125$

   $P = \frac{N}{D}$
   $P = \frac{48}{1.5}$
   $P = 32$

2. $a = \frac{1}{P}$
   $a = \frac{1}{16}$
   $\boxed{a = .0625}$

   $P = \frac{N}{D}$
   $P = \frac{48}{3}$
   $P = 16$

   $b = \frac{1.157}{P}$
   $\boxed{b = .0723}$

   $D_G = 3.0$
   $N_G = 48$

3. $D_R = D - 2b$
   $D_R = 3 - 2(.0723)$
   $D_R = 3 - .1446$
   $D_R = 2.8554$

4. $P = \frac{N}{D}$ then $D \times P = N$, $1.75 \times 20 = \boxed{35}$

5. $D_p = D_o - \left(\frac{1}{P} \times 2\right)$
   $D_p = D_o - \left(\frac{1}{24} \times 2\right)$
   $D_p = 3.333 - .083$
   $\boxed{D_p = 3.25}$

6. $P = \frac{N}{D}$
   $P = \frac{80}{2.5}$
   $\boxed{P = 32}$

7. $D_R = \frac{(N-2.314)}{P} = \frac{(32-2.314)}{P} = \frac{29.686}{16} = \boxed{1.855}$

$P = \frac{N}{D} = 16$

8. $D_o = \frac{(N+2)}{P} = \frac{(40+2)}{20} = \frac{42}{20} = 2.1$

$D_P = D_o - (\frac{1}{P} \times 2)$

$D_P = 2.1 - 1$

$\boxed{D_P = 2}$

9. $P = \frac{N}{D} = \frac{75}{3.208} = \boxed{23.38}$

10. $\frac{48}{P_g} = \frac{4}{1}$, $48 = (P_g \times 4)$, $\frac{48}{4} = P_g$, Pinion gear teeth = $\boxed{12}$

11. $h_t = \frac{2.157}{P} = \frac{2.157}{96} = \boxed{.0225}$

12. $P = \pi(\frac{D}{N})$

$P = \pi(\frac{16}{20})$

$P = 2.512$

13. $\pi\ 1.50 \times 250 \times 3 = 3532.5$ $\pi\ 3.00 \times 3 = 28.26$

$3532.5 \div 28.26 = \boxed{125}$

14. $\frac{\text{R.P.M. (Pinion gear)}}{\text{R.P.M. (Spur gear)}} = \frac{1050}{175} = \boxed{6:1}$

15. (1.5:1) for D as well as for teeth

16. $D_o = \frac{(N+2)}{P} = \frac{(120+2)}{48} = \frac{122}{48} = \boxed{2.54}$

17. $C = \frac{1}{2}(D_G + D_W)$

$C = \frac{1}{2}(.500 + 4.00)$

$C = \frac{1}{2}(4.5)$

$C = \boxed{2.25}$

18. ① $\frac{75}{15} = 5:1$ ② $\frac{3.125}{.625} = 5:1$ ③ $\frac{725}{145} = 5:1$

Chapter 17

1. Name and address of company, drawing title, drawing or part number, scale of the drawing, drafter name, date, checker name, date checked, tolerances, material, chief approving official name.

2. 1. order of size
   2. order of importance
   3. order of assembly

3. Consist of identification of problem, concepts and ideas, compromise solutions, models and prototypes, and production of working drawings.

4. A regular purchased part which requires only slight modifications to it. It needs a detail drawing to indicate modifications.

5. Drawing revisions are brought up at the ECR meeting. Here, all departments must agree to the change before such change can be made. When approved the committee issues an engineering change order (ECO), authorizing the change.

6. Subassemblies sometimes have machined operations done after assembly. There could be multi-subassemblies to an assembly.

7. An agreement signed by a designer, drafter or engineer giving the company the right to any new invention designed while in that company's employ.

8. An exact size or scaled drawing made from sketches in first steps of the design process. It is drawn by the designer or engineer and usually has only overall dimensions.

9. All dimensions included, title block complete, notes added, finish symbols, unnecessary dimensions, follows standards, clear dimensions and instructions.

10. Any information, charts or reference materials often used.

11. A drawing which shows how the parts of a product are assembled when completed. It contains necessary views in section, with a callout for each part.

12. In such cases the old drawing is stamped obsolete with a note "superseded by ..." with the number of the new drawing.

Chapter 18

1. When accuracy is important or where various points around a circle or arc must be established.