DOCUMENT RESUME

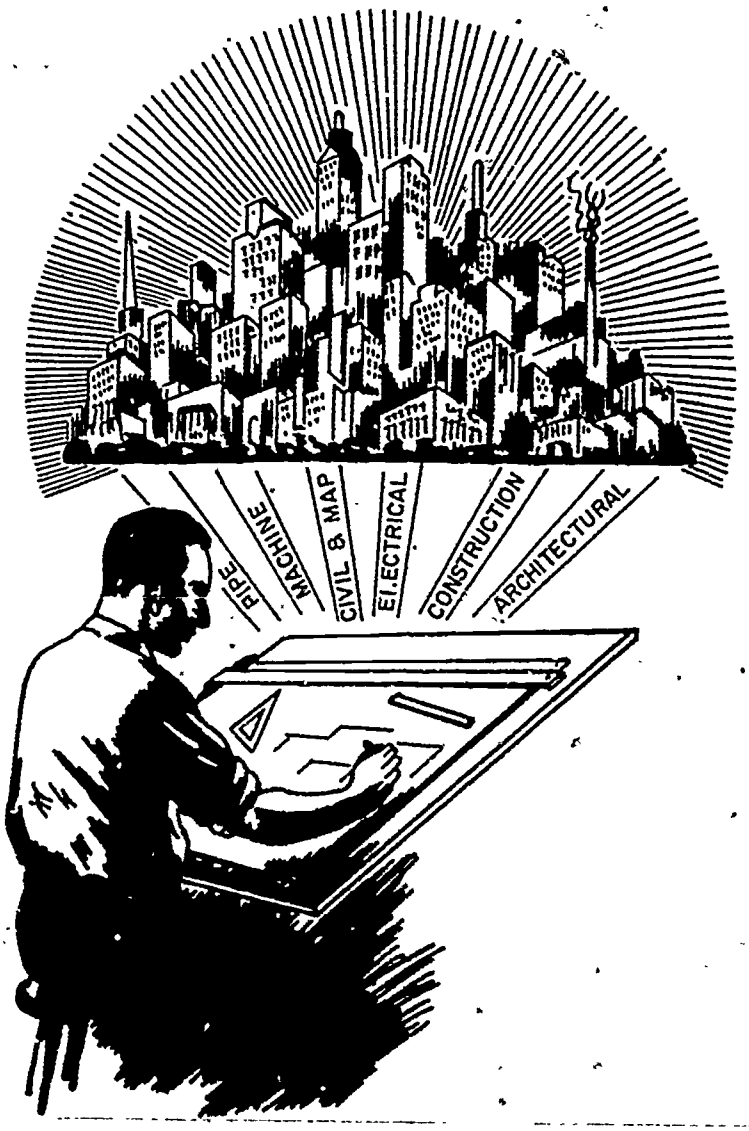
ED 124 773 95 CE 007 401

TITLE	Competency-Based Curriculum for Articulated Programs in Drafting. A Study for the Articulation of Competency-Based Curricula for the Coordination of Vocational-Technical Education Programs in Louisiana. Final Report. Volume III.
INSTITUTION	Louisiana State Dept. of Education, Baton Rouge. Div. of Vocational Education.
SPONS AGENCY	National Center for Educational Research and Development (DHEW/OE), Washington, D.C.
REPORT NO	VT-102-840
BUREAU NO	V0258VZ
PUB DATE	May 76
GRANT	OEG-0-74-1744
NOTE	105p.; For related documents, see CE 007 399-404
EDRS PRICE	MF-$0.83 HC-$6.01 Plus Postage.
DESCRIPTORS	Architectural Drafting; *Articulation (Program); *Drafting; Educational Objectives; Employment Opportunities; *Performance Based Education; Post Secondary Education; Secondary Education; *State Curriculum Guides; Vocational Education
IDENTIFIERS	Louisiana

ABSTRACT

The curriculum guide for drafting occupations is one of five guides written and field tested in a project to develop statewide articulated competency-based curricula in selected vocational education programs. Contents of the guide are divided into eight curriculum levels, and students should be able to enter the program at the appropriate level of their experience. The first four levels cover basic drafting skills, the fifth is a general knowledge level covering overlapping areas that each specific field has in common, and the last three levels are advanced levels in the fields of: Architecture, Mapping, Piping, Mechanical-Machinery, and Structural Steel Detailing. Related technical subjects and mathematics are offered at all levels. Each level is divided into teaching units and contains a brief description of the unit, performance objectives, and criterion-referenced measures. Following each of the curriculum levels is a list of job opportunities with their corresponding Dictionary of Occupational Titles code number. A three-level strength of materials curriculum is also included along with a bibliography. (RG)

COMPETENCY - Based Curriculum for ARTICULATED Programs in DRAFTING Occupations



Final Report

Project No. V0258VZ
Grant No. OEG-0-74-1744

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A STUDY FOR THE ARTICULATION OF COMPETENCY-BASED CURRICULA FOR THE COORDINATION OF VOCATIONAL-TECHNICAL EDUCATION PROGRAMS IN LOUISIANA

May 1976

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

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Competency-Based Curriculum for Articulated Programs in Drafting

Volume III of six volumes

Gertrude M. Enloe, Ed. D.
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The research reported herein was performed pursuant to a grant with the Office of Education, U.S. Department of Health, Education, and Welfare. Contractors undertaking such projects under Government sponsorship are encouraged to express freely their professional judgment in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent official Office of Education position or policy.

U.S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE

Office of Education

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PURPOSE OF THE STUDY

The Bureau of Vocational Education, Louisiana State Department of Education was awarded a grant to make a study for the articulation of competency-based curricula for the coordination of selected vocational-technical education programs. The five areas selected for study and development of competency-based curricula were: (1) Air-conditioning/Refrigeration, (2) Drafting, (3) Electronics, (4) Nursing, and (5) Office Occupations.

A team of writers worked during the Summer of 1975 developing curricula or guides for teachers on the three institutional levels: Secondary, Post-Secondary, Vocational-Technical, and Associate Degree programs on the collegiate level.

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REPORT OF THE ARTICULATION COMMITTEE ON DRAFTING

The committee has written a curriculum for drafting in the post-secondary schools composed of performance objectives and criterion-referenced measures which are based on competency levels so it can be challenged by graduates from secondary schools, transferees from other post-secondary schools and college students. In this manner, costly repetition of teaching can be eliminated.

Whereas a secondary school student may enter drafting at the ninth grade level and take drafting for one to three hours per day, the post-secondary student must have a high school diploma or the equivalent and attend six hours per day. Therefore, the same curriculum cannot be used for both. With the exception of the related studies, the high school graduate should be able to enter the program somewhere in the fourth level.

The college student, while he will lack the technical skill the post-secondary student should have at the fourth level, should have the necessary knowledge to enter at that level, and, according to the courses he took in college, should be able to challenge some of the related areas.

In the same manner, a post-secondary student going to college, should be able to challenge the drafting courses and get credit for them.

The curriculum has been divided into eight levels. The first four levels cover the basic drafting skills taught by all three types of schools. Level I is a very low level and would be for the student who did not do well in secondary, did not continue or has been out of school for some time. The next three levels develop the drafting skills until at the end of the fourth the student is well versed in drafting techniques and is ready to learn specific skills. The fifth level is a general knowledge level covering overlapping areas that each specific field has in common. The last three levels are advanced levels in particular fields. Those selected are: Architecture, Mapping, Mechanical-Machinery, Piping, and Structural Steel Detailing. Related technical subjects and math are offered at all levels.

Strength of Materials is set up as a related subject at the last four levels. While the student who is talented in math can benefit greatly by this course, unless a student desires to learn this, he should not be influenced to do so because many jobs do not require any knowledge of it. In the same situation, the student who is good in math can and should take all the math courses offered. If a student is only able to complete the first level, he should not be discouraged because there are many jobs that do not use math beyond that level.

Each level is divided into units for teaching. If a student is not able to pass all the units challenged in a level, he should be permitted to bypass the units he knows and only study the units he does not know.

In setting up the performance objectives and the criterion-referenced measures, the committee has divided them into four areas--Lettering, Use of Equipment, Drawing Ability and Dimensioning. Obviously these areas overlap each other and many performances can be included in more than one area. The division is made so the student's continuing progress in each area can be checked. Failure to meet the instructor's standards in one area would not mean failing the unit provided the subject material was learned--merely that the student must work harder in that area. Furthermore by setting up these areas, the instructor has some way of knowing what other instructors are expecting from their students.

L E V E L I

CURRICULUM

Unit 1 Introduction
Unit 2 Graphic Instruments - Use and Care
Unit 3 Applied Geometry - Arcs and Circles
Unit 4 Applied Geometry - Straight Lines
Unit 5 Freehand Sketching - Orthographic and Pictorial

RELATED SUBJECTS

Graphic Reproductions

Math - Fractions, Decimal Fractions, Percentages, Ratios and Proportion, Metric Measure

Suggested length of time - 9 weeks

Unit 1 - Introduction

The student is introduced to the history and purpose of drafting and given an explanation of the alphabet of lines, different grades of pencils, correct way to hold and use pencils. The student learns the different types of lettering and is instructed in the stroke system of lettering using upper case vertical letters.

Unit 2 - Graphic Instruments - Use and Care.

The student is given instruction in the use of the T-Square, 30^{o} and 45^{o} triangles, protractor, compass, dividers, Architect's scale, Engineer's scale and metric scale. The student is also taught to use Ames or similar lettering guides. The student must do working drawings which are scaled accurately, possess good line quality, and are dimensioned fully.

Unit 3 - Applied Geometry - Arcs and Circles

The student is taught geometrical construction of arcs tangent to lines and arcs tangent to arcs. The student must use a compass to draw working drawings using arcs and must be able to dimension arcs, chords and angles.

Unit 4 - Applied Geometry - Straight Line

The student is taught how to divide lines and angles by using instruments or scales. The student must use a protractor to draw polygons and is taught how to draw triangles, squares, pentagons, hexagons, and other multi-sided polygons in addition to the construction of odd shaped polygons and the transfer of polygons.

Unit 5 - Freehand Sketching - Orthographics and Pictorial

The student is introduced to orthographic views by drawing front, top, and side views from isometric sketches. The student is taught how to provide missing lines or views and to draw an isometric freehand if necessary to develop views.

RELATED SUBJECTS

Graphic Reproductions

The student is taught basic information about the preparation of drawings to include sheet sizes, border lines, title blocks and schedules. The student learns the various types of drafting media used in industry such as tracing paper, tracing cloth, film, fade-out paper, reproducible paper, Federal aid sheets and film stick-ons may be used. The student is instructed in the use and care of a print machine and how a properly developed print looks. The student is also instructed in the preparation of drawings for microfilm and in how microfilm is made, used, and stored.

Math

Unit 1 - Fractions

The student is taught reduction of whole or mixed numbers to improper fractions and the reverse, reduction of fractions to the lowest terms, changing the denominators of fractions, addition of fractions and mixed numbers, subtraction of whole and mixed numbers, multiplication and division of fractions with emphasis on practical application.

Unit 2 - Decimal Fractions

The student learns to reduce decimal fractions to common fractions, change common fractions to decimal fractions, use a table of decimal equivalents, convert dimensions and to add, subtract, multiply, and divide decimals.

Unit 3 - Percentages

The student is taught percentage, base and rate and how to find the one missing from two that are known.

Unit 4 - Ratio and Proportion

The student learns how to set up ratios and their practical applications as in the 3, 4, and 5 triangle and congruent triangles and gears along with learning about proportion and averages.

Unit 5 - Metric Measure

The student is taught the metric units of length, area,

volume and weight in addition to converting from English measurements to metric measurements.

LETTERING

Performance Objectives:

Upon completion of this unit the student must perform within an acceptable degree, according to the instructor's standards, the following skills:

1. Letter using upper case gothic letters.
2. Letter with reasonable uniformity with optical spacing between letters the same and space words adequate for easy reading.
3. Use guide lines for all letters and numbers.
4. Make numerator and denominator numerals of fractions 3/4 size of whole numbers.

Criterion-Referenced Measures:

At the end of the unit, the student must be checked to see that he:

1. Uses guide lines for all his lettering.
2. Does not mix upper and lower case letters.
3. Makes each part of the fraction 3/4 the size of the whole number.
4. Uses the stroke system.
5. Uses upper case vertical gothic letters.
6. Spaces between letters and words with reasonable standard style.
7. Makes letters proportional in width according to standards set up in textbooks.

USE OF EQUIPMENT

Performance Objectives.

Upon completion of this unit the student must perform within an acceptable degree, according to the instructor's standards, the following skills:

1. Sharpen, hold and use a drawing pencil correctly.
2. Use a T-Square, parallel bar and triangles correctly.
3. Demonstrate knowledge of the proper use of the protractor.
4. Draw full scale and half scale drawings accurately.
5. Demonstrate the knowledge that he can read the architect's 16 or full scale and the engineer's 10 and 20 scale.
6. Demonstrate his knowledge of the proper care and use of a compass and dividers to the satisfaction of the instructor.
7. Produce clean drawings.

Criterion-Referenced Measures:

Equipment used at this level consists of:

Pencils or lead holders	T-Square	Hand eraser
30-60 triangle	Parallel bar	Erasing shield
45 triangle	Architect's scale	Sandpaper pad
Protractor	Engineer's scale	Dry cleaning pad
Compass	Metric scale	
Dividers	Lettering guide	

The student must be checked to see that he:

1. Holds pencil correctly.
2. Rolls the pencil while he draws.
3. Makes the stroke in the right direction.
4. Holds the T-Square tightly against the board.
5. Uses only the top side of the T-Square or Parallel bar.
6. Uses the triangles singly or in combination.
7. Uses the protractor correctly.
8. Uses full scale accurately, both architect's and engineer's
9. Uses half scale accurately, on engineer's and mechanical if that scale is available.
10. Uses lettering guide to draw all his lettering guide lines.
11. Demonstrates an understanding of the care of a compass and dividers.
12. Sharpens compass point correctly.
13. Uses compass correctly.
14. Uses dividers correctly.
15. Does not use dry cleaning pad as a scrubber.
16. Cares for, cleans and adjusts a parallel bar and changes the cord in the bar.

DRAWING ABILITY

Performance Objectives:

Upon completion of this unit the student must perform within an acceptable degree, according to the instructor's standards, the following skills:

1. Draw a working drawing of a one view object demonstrating his knowledge of the alphabet of lines, his ability to use the pencil and eraser correctly in drawing the lines, his knowledge of the correct pencil to use and his ability to draw corners and intersections correctly.
2. Recognize and practice consistency in weight of lines and size and shape of arrowheads.
3. Locate centers of arcs by means of applied geometry.
4. Draw lines and arcs connecting with each other with no visible points of tangency.
5. Bisect and trisect angles and lines and divide lines into equal segments.

6. Transfer polygons by means of triangulation or boxing.
7. Draw orthographic views in proper order.
8. Draw the missing lines or missing views from orthographic sketches.
9. Sketch an isometric from orthographic views.

Criterion-Referenced Measures:

At the end of the unit the student must be checked to see that he:

1. Follows the alphabet of lines.
2. Draws pencil lines so that they are sharp and regular in width and weight.
3. Erases and redraws lines so the erasure does not show.
4. Draws arrowheads so they are consistent in appearance and approximately 1/8" long and one third as wide as they are long.
5. Draws corners that connect but do not lap.
6. Draws intersections so all lines come from the same point.
7. Connects lines and arcs so there is no visible point of tangency.
8. Bisects angles and lines.
9. Divides lines into a given number of equal parts.
10. Transfers polygons by triangulation or boxing.
11. Transfers lines (draw parallel and perpendicular lines) by means of 2 triangles.
12. Draws arcs tangent to arcs.
13. Draws arcs tangent to lines using geometric construction.
14. Locates center of arc when it is not specifically given, as when the arc passes through a given point and is tangent to a line.
15. Draws all six views of an object in the proper order.
16. Provides the missing view or the missing lines.
17. Sketches an isometric from two or three orthographic views.
18. Keeps all drawings clean.

DIMENSIONING

Performance Objectives:

Upon completion of this unit the student must perform within an acceptable degree, according to the instructor's standards, the following skills:

1. Make a single view drawing, applying the dimensions as set forth in a problem the instructor selects from a textbook. The student must follow ANSI Y14.5 standards (American National Standards Institute).

Demonstrate basic dimensioning procedures as set forth in ANSI Y14.5 to the extent that he:

1. Leaves a 1/16" gap between object and extension lines.
2. Extends the extension lines 1/8" beyond dimension lines.
3. Leaves 3/8" space between the object and the first dimension line.
4. Leaves 1/4" space between dimension lines.
5. Breaks the dimension line and inserts the dimension in the space or any method approved by ANSI.
6. Shows arrowheads at ends of dimension lines.
7. Draws dimension lines parallel to the surface to be measured and perpendicular to the extension lines.
8. Refrains from crossing dimension lines.
9. Draws leaders with a straight line at an angle of 30^{o}, 45^{o}, 60^{o} or any angle except vertical or horizontal.
10. Dimensions a circle by its diameter and an arc by its radius.
11. Draws dimensions for circles and arcs in a radial direction.
12. Shows one arrowhead on dimensions for radii and two arrowheads on dimensions for diameters.
13. Dimensions arcs, angles and chords, according to standards set forth in ANSI Y14.5.

RELATED SUBJECTS: GRAPHIC REPRODUCTION

Performance Objectives:

Upon completion of this unit of related instruction the student must perform within an acceptable degree, according to the instructor's standards, the following skills:

1. Prepare a standard sheet of paper for a drawing, sizing it correctly and drawing title block and border lines on it.
2. Demonstrate his knowledge of the different sizes of standard sheets.
3. Demonstrate familiarity with the various forms of drafting media such as tracing paper, tracing cloth, film, and the various grades used and why. He must demonstrate a knowledge of why different media are selected for different drawings and the advantages and disadvantages of each.
4. Exhibit a familiarity with reproduction processes used in industry such as dry process reproduction machines, office copiers and microfilm.
5. Demonstrate his familiarity with the dry process machine by making acceptable prints of his work.

Criterion-Referenced Measures:

At the end of this unit, the student must demonstrate ability to:

1. Use uniform sizes of paper and not to change from that size without good reason. (Source: ANSI Y14.1)
2. Always use border lines and title blocks.
3. Fill in a title block correctly even though it will be months before he makes multi-page drawings, showing him where and why the number of pages are shown, where to fill in the company (or school) name, where to show the part number, scale and his name and where to post revisions and see who checked it. (Source: copies of prints from industry)
4. Draw schedules for parts lists and lists of materials and where to locate them on the drawing.
5. Use various types of media a draftsman uses and the advantages and disadvantages of each. (Source: Salesmen's samples)
6. Use various aids the draftsman uses: tape, rub-offs, film, stick-ons.
7. Clean a dry process reproduction machine.
8. Operate a dry process reproduction machine.
9. Properly develop prints.
10. Prepare a drawing for microfilm. (Source: Commercial Salesrcoms)
11. Describe the process by which microfiims are made.
12. Read microfilms and microfiche.
13. File microfilm.
14. Assist in changing the developer in a dry process reproduction machine.
15. Assist in removing the bulb from a dry process reproduction machine for the purpose of cleaning or replacing.

Where time and budget permit, at some advanced level, the student should be permitted to work with the various media and aids used in industry.

RELATED SUBJECTS

MATH

Performance Objectives:

Upon completion of this unit of related instruction the student must perform within an acceptable degree, according to the instructor's standards, the following skills:

1. Add, subtract, multiply or divide whole numbers and numbers containing fractions.
2. Reduce answers to problems containing fractions to mixed numbers with the lowest terms for the fractions.

3. Add, subtract, multiply and divide numbers containing decimal fractions.
4. Convert fractions to decimals and decimals to fractions.
5. Determine averages.
6. Reduce whole or mixed numbers to improper fractions.
7. Reduce improper fractions to whole or mixed numbers.
8. Reduce a fraction to its lowest terms.
9. Change a fraction with a given denominator to one with a higher denominator.
10. Reduce two or more fractions with different denominators to equivalent fractions with a common denominator.
11. Add fractions and mixed numbers.
12. Subtract fractions and mixed numbers.
13. Divide fractions.
14. Reduce decimal fractions to common fractions.
15. Change common fractions to decimal fractions.
16. Add decimals lining up decimal points.
17. Subtract decimals.
18. Multiply decimals.
19. Divide decimals.
20. Work with percentages. Given any two of the three parts, percentage, base, and rate, he must be able to find the missing one.
21. Reduce a ratio to the lowest terms.
22. Set up proportions using ratios.
23. Determine averages from given lists.

JOB OPPORTUNITIES
LEVEL 1

	D.O.T. Code
Blueprinting-Machine Operator	979.782
Messenger	230.878
Blueprint Trimmer	920.887

L E V E L II

CURRICULUM

Unit 1 Applied Geometry - Curves
Unit 2 Orthographics - Multiview
Unit 3 Isometrics
Unit 4 Obliques

RELATED SUBJECTS

Metals

Math - Algebra

Suggested length of time - 9 weeks

Unit 1 - Applied Geometry - Curves

The student is given instruction in drawing curves other than arcs and circles such as ellipses, involutes, Spiral of Archimedes, helixes parabolas, cycloids, epicycloids and hypocycloids. A student using irregular curve, must be able to draw related lines such as major and minor diameters and tangents.

Unit 2 - Orthographics - Multiview

The student is given instruction in drawing simple multiview drawings from missing view problems; stresses line quality, accuracy, correct dimensioning--"textbook solution". If desired, student may draw isometrics of the problems to help himself understand better.

Unit 3 - Isometrics

The student learns the principles of isometrics, how to draw an isometric drawing and a four-centered ellipse with all drawings to be fully dimensioned. Ellipse templates are allowed in advanced isometric drawings. Section drawings are to be included at this point. The student is introduced to the use of ink in this unit and is required to turn in accurate drawings which have good linework.

Unit 4 - Obliques

The student is taught how to construct oblique drawings with variations such as cabinet and cavalier drawings included. The student should be able to use both technical pens and ruling pens.

RELATED SUBJECTS

Metals

The student learns the necessary information about non-ferrous and ferrous metals so an understanding of why particular metals are used in particular cases can be gained. The student is taught the SAE (Society of Automotive Engineers) and AISI (American Iron and Steel Institute) numbering system for metals in addition to how castings are made and the advantages of them. The various methods of treating metal, of preserving metal from rusting and of testing metal to see if it meets specifications are also introduced to the student.

Math

This unit introduces the student to a practical form of algebra which includes negative numbers, use of letters, substitution, addition and subtraction, multiplication and division and equations that is most likely to be used.

LETTERING

Performance Objectives:

Upon completion of this unit the student must perform within an acceptable degree, according to the instructor's standards, the following skills:

1. Letter notes on a drawing in a uniform and consistent manner using guide lines.
2. Transfer notes without misspelling or omitting words.
3. Make lettering strokes dark enough to print with his first effort.
4. Letter using either the proper pencil or a technical pen.

Criterion-Referenced Measures:

At the end of this unit the student must demonstrate ability to:

1. Use guide lines for all numbers and letters.
2. Fill all the space between the guide lines with the letters but not permit letters to extend past the guide lines.
3. Make letters uniform size with the appearance of uniform space between them.
4. Letter with a pencil using upper case Gothic letters using the stroke method.
5. Space words far enough apart for easy readability and be consistent in the spacing so that the words at the end of the notes have the same spacing as the words at the beginning.

6. Transfer notes without misspelling words or omitting them.
7. Be reasonably consistent in having all vertical strokes vertical and letters identical in shape--i.e., all E's must have the middle bar at the same height.
8. Letter with a technical pen using ink.
9. Make strokes heavy enough to print with the initial stroke so that repetition of the same strokes is unnecessary.

USE OF EQUIPMENT

Performance Objectives:

Upon completion of this unit the student must perform within an acceptable degree, according to the instructor's standards, the following skills:

1. Demonstrate that he knows how to hold and use a pencil correctly.
2. Demonstrate that he knows how to use the equipment previously issued correctly.
3. Demonstrate that he can draw accurately at any accepted scale.
4. Demonstrate that he knows how to use and care for a technical pen.
5. Demonstrate his ability to use a ruling pen.
6. Demonstrate that he knows how to use an electric eraser correctly.
7. Demonstrate that he knows how to use an irregular curve correctly.

Criterion-Referenced Measures:

Additional equipment added at this level, includes:

French or irregular curve
Technical pen
Ruling pen
Electric eraser

At the end of this unit, the student demonstrates ability to:

1. Use a pencil correctly.
2. Use triangles, T-Square, parallel bar, compass, dividers and protractor correctly.
3. Use either an architect's, engineer's or metric scale or any acceptable scale to lay off a specific dimension and to measure the true length of a given line.
4. Disassemble, clean and refill a technical pen and keep it in good working order.
5. Hold and use a technical pen correctly.
6. Select the correct size of technical pen to use in following the alphabet of lines.

7. Clean and store a ruling pen and ruling compass.
8. Hold and draw with a ruling pen and ruling compass, adjust the width of the line in order to follow the alphabet of lines.
9. Use an electric eraser by plugging and unplugging according to safe practices, storing properly and observing safety in its use.
10. Use irregular curve correctly by lightly sketching in the curve and then filling it in a segment at a time.

DRAWING ABILITY

Performance Objectives:

Upon completion of this unit the student must perform within an acceptable degree, according to the instructor's standards, the following skills:

1. Draw a simple multiview orthographic drawing from a missing view, missing line or isometric drawing placing all dimensions and notes on the drawing and following the alphabet of lines.
2. Construct irregular curves using an irregular curve in such a manner as to have a perfectly smooth curve with no joints showing.
3. Draw an isometric and dimension it fully.
4. Draw a four centered ellipse.
5. Draw obliques; both cavalier and cabinet.
6. Draw using ink, without ink smears or holes in the paper and with lines of consistent width.

Criterion-Referenced Measures:

At the end of this unit, the student must demonstrate ability to:

1. Draw a working drawing with the lines consistent and uniform in appearance, following the alphabet of lines, having all notes and numbers the same size with all lines to scale and views in correct sequence using pencil and ink in separate drawings.
2. Draw curves using an irregular curve so that the instructor cannot find any corners or visible laps.
3. Construct an ellipse given conjugate diameters or major and minor diameters.
4. (Using the textbook if necessary) demonstrate his ability to draw irregular curves such as the parabola, spiral of Archimedes, helix, involute, cycloid, epicycloid, hypocycloid.
5. Draw an isometric fully dimensioned.
6. Draw a four-centered ellipse.
7. Draw a cavalier and cabinet drawing.

8. Make ink drawings without ink smears or pencil smudges.
9. Connect ink lines so there is no visible point of connection.

DIMENSIONING

Performance Objectives:

Upon completion of this unit the student must perform within an acceptable degree, according to the instructor's standards, the following skills:

1. Transfer dimensions from a given problem spacing the lines properly, including all dimensions, drawing all arrowheads equal size and following the alphabet of lines.
2. Dimension an isometric.
3. Look up information about dimensioning using the ANSI Y14.5 standards.

Criterion-Referenced Measures:

The student demonstrates ability to:

1. Fully dimension a drawing giving all dimensions with the lines located in the proper relationship to each other.
2. Show all arrowheads.
3. Draw arrowheads the same size--approximately 1/8" long with the head one-third as wide as it is long.
4. Explain unidirectional and aligned system of dimensioning.
5. Refrain from extending center lines or extension lines from one view to another.
6. Give the majority of dimensions on 2 views.
7. Give related dimensions on the same view.
8. Give dimensions on a view which indicate a true shape.
9. Place all dimensions so they read from the bottom and right, never left.
10. Refrain from duplicating dimensions.
11. Omit one dimension in a string of dimensions for the accumulation of tolerances to go into.

RELATED SUBJECTS

METALS

Performance Objectives:

Upon completion of this unit of related instruction the student must perform within an acceptable degree, according to the instructor's standards, the following skills:

1. Explain the different metals specified in his drawings.

2. Demonstrate his knowledge of SAE and AISI numbers and why one is more satisfactory in a given situation than another.
3. Draw castings showing rounds, fillets and runouts correctly.
4. Show finish marks where applicable on his drawings showing castings.

Criterion-Referenced Measures:

At the end of this unit, the student demonstrates ability to:

1. Name at least three non-ferrous metals, given properties of each and name a machine part each is used for. (Source: Bibliographical references 68, 41 and U. S. Bureau of Mines films).
2. Explain the SAE and AISI numbering systems for metals and give examples. (Source: Bibliographical references 68 and 41)
3. Identify a casting, and explain how it is made; what types of molds are used; and what a green sand core is.
4. Specify reasons for special design in castings--rounds, fillets, run outs.
5. Recognize and construct special casting drawings.
6. Explain various methods of manufacturing steel.
7. Discuss methods of treating metal to preserve it from rusting.
8. Describe methods of testing metals to see if they comply.
9. Identify and use the ASTM (American Society for Testing and Materials) standards.

RELATED SUBJECTS

MATH

Performance Objective:

Upon completion of this unit of related instruction the student must perform within an acceptable degree, according to the instructor's standards, the following skills:

1. The student will be able to perform simple algebraic equations.

Criterion-Referenced Measures:

At this level, the student must:

1. Use negative numbers.
2. Demonstrate an understanding of absolute values, factors, power, exponents, coefficients, and roots.
3. Substitute letters for numbers in problems.
4. Add and subtract similar terms.
5. Subtract numbers or terms by changing the sign and then combining them.

6. Multiply algebraic terms.
7. Divide algebraic terms.
8. Solve problems using equations.

At this level it is recommended that students be allowed to use a pocket electronic calculator to perform required calculations.

JOB OPPORTUNITIES
LEVEL II

	D.O.T. Code
Blueprinting-Machine Operator	979.782
Messenger	230.878
Blueprint Trimmer	920.887
Engineering Clerk and Drafting Clerk	249.281
Tracer-Draftsman, Junior	017.281

L E V E L III

CURRICULUM

Unit 1 Orthographics - Decision Making
Unit 2 Auxiliaries
Unit 3 Sections
Unit 4 Assembly Drawings

RELATED SUBJECTS

Shop Processes

Math - Trigonometry

Suggested length of time - 9 weeks

Unit 1 - Orthographics - Decision Making

The student learns to make decisions as to which views in an orthographic drawing are necessary. Emphasis is placed on functional drafting which omits unnecessary lines, views and instructions and helps the student decide the best presentation of work to the mechanic. The student gains basic knowledge of fasteners which must be applied in assigned problems using simplified or schematic symbols.

Unit 2 - Auxiliaries

The student is taught how to draw auxiliaries to include simple normal views, edge views and working drawings that require work on several views at a time during development of the problem.

Unit 3 - Sections

The student learns to section correctly by constructing various types of sections such as full, half, broken-out, revolved or rotated, removed, offset, aligned, auxiliary and thin sections. The special conditions required for showing ribs, spokes, shafts, screws, bolts and pins are introduced along with how to draw S or conventional breaks for round and rectangular parts. The student also learns how to draw partial views.

Unit 4 - Assembly Drawings

The student learns to draw general assembly drawings using full or half sections with an additional view if desired. Parts list must be given with the proper identification.

RELATED SUBJECTS

SHOP PROCESSES

Math - Trigonometry

The student is taught trigonometric functions, use of tables and solution of right triangles.

LETTERING

Performance Objectives:

Upon completion of this unit the student must perform within an acceptable degree, according to the instructor's standards, the following skills:

1. Letter drawings so that the finished product compares favorably with working drawings from industry.
2. Write notes which are clear, concise and brief using abbreviations where permissible.
3. Describe work to be done to various parts both as to manner and degree.
4. Use a Leroy or similar lettering instrument to make lettering uniform and mechnical.
5. Fill in a parts list.

Criterion-Referenced Measures:

At the end of this unit, the student must:

1. Produce assigned work showing lettering comparable with lettering done in industry.
2. Compose notes so information is clear, accurate, and complete with only one interpretation possible.
3. Locate acceptable abbreviations.
4. Properly place notes on a drawing.
5. Avoid duplicating information given elsewhere.
6. Letter uniformly using a Leroy or similar lettering instrument.
7. Follow proper procedure for filling in a parts list.
8. Write in an acceptable manner and explain notes referring to machining processes.

USE OF EQUIPMENT

Performance Objectives:

Upon completion of this unit the student must perform within an acceptable degree, according to the instructor's standards, the following skills:

1. Demonstrate the ability to care for and use Leroy or similar lettering equipment by some means such as lettering

in a parts list using the equipment.
2. Use an adjustable triangle to demonstrate an understanding of complementary angles by knowing how to turn the triangle and when it cannot be used without resetting.
3. Demonstrate the ability to use a drafting machine correctly, adjust it when necessary and make minor repairs.
4. Demonstrate an understanding of the drafting machine by reducing the time required to turn out drawings.

Criterion-Referenced Measures:

Additional equipment added at this level includes:

Lettering set
Adjustable triangle
Drafting machine

The student must exhibit the ability to:

1. Clean, set up and store Leroy or similar lettering equipment.
2. Set an adjustable triangle.
3. Use a drafting machine by selecting the correct scales and adjusting for the angles required on the drawing. The student must demonstrate an understanding of how to make other adjustments and minor repairs.
4. Demonstrate a knowledge of the primary advantage of using the drafting machine which is to save the draftsman's time and to improve his speed.

DRAWING ABILITY

Performance Objectives:

Upon completion of this unit the student must perform within an acceptable degree, according to the instructor's standards, the following skills:

1. Make the decision as to which views are necessary to enable the mechanic to build a single part from a working drawing. The student must decide which lines do not contribute to the building or understanding and should be omitted. The student also must decide which dimensions to use and where to locate them.
2. Make a drawing in a workmanlike manner, spacing the views, notes and dimensions so they are not crowded and locating them on the sheet with the proper space around them.
3. Draw threaded fasteners, both internal and external threads.
4. Draw keys and keyways.

5. Draw auxiliaries either showing a reference plane or implying it by "unfolding" the drawing along it.
6. Decide what type of section will develop the drawing best and then draw it, whether it is a full, half, broken-out, revolved, removed, offset, aligned auxiliary or thin section.
7. Make an assembly drawing and provide and fill out a parts list for it.

Criterion-Referenced Measures:

At the end of the unit, the student must:

1. Decide which views are necessary to show in order for the mechanic to build the part.
2. Lay out the views on a drawing using proper placement to include adequate space between views and adequate space to the border. The student must develop personal judgment in placing dimensions and notes to avoid crowding.
3. Use personal judgment in omitting unnecessary information, views and lines which complicate the drawing.
4. Draw simplified or schematic form of threaded fastener, for external threads, internal threads, blind holes and through holes.
5. Explain the difference between screws, bolts and studs.
6. Draw a key and a keyway.
7. Draw an auxiliary; both simple normal view and edge view.
8. Develop a drawing working from one view to the next, rather than drawing one complete view before proceeding to the next.
9. Draw a full section revolving ribs, spokes and holes as necessary for the conventionalized representation.
10. Draw a half section.
11. Draw broken out sections showing internal threads in section and external threads in elevation.
12. Draw revolved sections showing ribs, etc. in detail on the elevation.
13. Draw removed, offset, aligned auxiliary and thin sections and make a decision as to which will best demonstrate to the mechanic the proper way to build the part, enlarging the scale if required.
14. Draw a partial view.
15. Draw correct way to break round and rectangular parts.
16. Make an assembly drawing showing the parts in section as they are assembled with the correct hatch marks. The bubbles must be lined up vertically and horizontally and numbered consecutively. Only overall dimensions must be shown if any are necessary. The parts list must be filled out with the number of the bubble, the title of each part, the number required and the material to be used.

DIMENSIONING

Performance Objectives:

Upon completion of this unit the student must perform within an acceptable degree, according to the instructor's standards, the following skills:

1. Use the correct principles of dimensioning as set forth in ANSI Y14.5.
2. Place dimensions on a drawing in the proper location.
3. When the proper location of a dimension is doubtful, place the dimension in a location where the meaning is clear and the mechanic can locate and read it.
4. Develop a way to dimension by first breaking down the object into geometric shapes and dimensioning and locating them in respect to each other and finally checking the dimensions according to shop processes to see if they can be clarified.
5. Dimension various shapes.
6. Dimension according to shop processes.

Criterion-Referenced Measures:

At the end of this unit, the student must:

1. Explain the technique of dimensioning as set forth in ANSI Y14.5.
2. Place dimensions correctly.
3. Demonstrate the importance of a geometric breakdown in dimensioning by first giving the size dimensions describing the shape and then giving the dimensions locating the geometric shapes in relation to each other.
4. Place the size dimensions on a prism.
5. Place the size dimensions on a cylinder.
6. Place the size dimensions on miscellaneous shapes.
7. Specify holes sizes.
8. Locate holes, grooves, slots, chamfers, etc.
9. Represent a bolt circle and specify the holes.
10. Represent finished surfaces.
11. Represent dimension rounds, fillets and runouts.

RELATED SUBJECTS

SHOP PROCESSES

Unit 1 - Types of Processes

The student is introduced to the five basic types of machine processes: (1) shaping and planing; (2) milling; (3) drilling, reaming and boring; (4) broaching, sawing and filing; (5) grinding, lapping, honing and superfinishing in addition to how tapers are made.

Unit 2 - Tolerancing

The student learns the amount of variation permitted in the size of a part or the location of points or surfaces. The student also learns upper and lower limits for various machine processes along with unilateral and bilateral tolerance.

Unit 3 - Fits

The student is taught the different types of fits: clearance, interference, transition and line and how to use tables to determine allowable tolerances for five types of fits: running or sliding clearance, locational clearance, transition clearance or interference, locational interference and force or shrink.

Unit 4 - Finishes

The student learns about surface finish measurement--roughness, waviness, lay and flaws and about the range of surface finishes that can be produced by different processes and the heights allowed.

Unit 5 - Measuring devices

The student is introduced to the most common measuring devices from the steel rule through the various types of micrometer calipers and about the types of gauges--mechanical including plug gauges, ring gauges, and snap gauges and explains about comparative gauges such as mechanical, electrical, air and optical.

RELATED SUBJECTS

SHOP PROCESSES

Performance Objective:

1. Student must be able to take a machined piece from a unit given in a textbook and describe what shop processes are necessary to finish it, how much tolerance will be allowed, what type of fit it has, what allowable surface roughness it may have and how to test it for compliance. Work must be completed to the satisfaction of the instructor.

Criterion-Referenced Measures:

At the end of this unit, the student must:

1. Describe how a shaper works and show the types of internal and external surfaces best produced by it.

2. List the tolerances allowable by a shaper and what fits could be made by it and what waviness range is normal for it.
3. Explain the difference between a shaper and a planer.
4. Explain the difference between vertical and horizontal milling machines and what types of cuts are produced by them.
5. Explain the difference between drilling, reaming, and boring and which follows which.
6. List the tolerances allowable by each and what fits could be made by it and what waviness range is normal for it.
7. Explain the broaching process.
8. List the tolerances allowable by broaching, what fits are made by this process and what waviness range is normal for it.
9. Name the types of saws and know how much material is used in the process of sawing with different types of saws.
10. Know how filing on a reciprocating machine is done.
11. Know difference in procedures for grinding, lapping and honing.
12. List the tolerances allowable by grinding, lapping and honing, what fits are made by these processes and what waviness range is normal for them.
13. Name the types of errors in boring that can be corrected by honing--such as rainbow, taper, out of round, waviness, bell mouth, etc.
14. Compare surface roughness produced by methods other than machining such as sandcasting, forging, permanent-mold casting, die-casting, rolled and cold drawn, extruded.
15. Use a micrometer.
16. Tell which type of go-no-go mechanical gauge to use on internal and external diameters.
17. Demonstrate knowledge of how tapers are drawn and dimensioned.

RELATED SUBJECTS

MATH - TRIGONOMETRY

Performance Objectives:

Upon completion of this unit of related instruction the student must perform within an acceptable degree, according to the instructor's standards, the following skills:

1. Solve for a missing dimension or angle of a right triangle.
2. Use the trigonometric tables interpolating when necessary.

Criterion-Referenced Measures:

The student must:

1. Write the formulas for all six trigonometric functions
2. Set up equations to solve for the missing sides or angles of a right triangle when 2 dimensions are given, with the exception of two angles.
3. Use the trigonometric tables, both to convert angles into a constant of one of the functions or to convert the constant into an angle.
4. Interpolate when the tables do not carry the functions far enough.

JOB OPPORTUNITIES
LEVEL III

	D.O.T. Code
Blueprinting-Machine Operator	979.782
Messenger	230.878
Blueprint Trimmer	920.887
Engineering Clerk and Drafting Clerk	249.281
Tracer-Draftsman, Junior	017.281

L E V E L IV

CURRICULUM

Unit 1 Detail Drawings
Unit 2 Revolutions
Unit 3 Developments
Unit 4 Intersections

RELATED SUBJECTS

Welding

Math - Plane and Solid Geometry

Suggested length of time - 9 weeks

Unit 1 - Detail Drawings

The student learns to make a drawing of a single piece giving the complete and exact description to include: the shape, size, material and finish of the piece. The student is taught to provide such information as the shop operations, limits of accuracy and number of parts wanted.

Unit 2 - Revolutions

The student is taught how to make successive revolutions of a plane and a prism in either a clockwise or counterclockwise direction and how to determine the true length of a line using revolution.

Unit 3 - Developments

The student learns how to make developments or patterns of various shapes; prisms, cylinders, cones (right angles or slanted), with various shapes cut out of them. The student must revolve lines to get true length and be able to use parallel line method, radial line method and triangulations to solve problems.

Unit 4 - Intersections

The student is taught how to draw the line of intersection between two geometric surfaces such as two prisms, two cylinders, a prism and a cylinder or a cylinder and a cone.

LETTERING

Performance Objectives:

Upon completion of this unit the student must perform within an acceptable degree, according to the instructor's standards, the following skills:

1. Use horizontal guide lines that are extremely thin, light and gray so as not to appear on prints.
2. Use vertical or slanted guide lines if needed.
3. Perform freehand lettering rapidly with uniform slope, height, spacing, boldness of strokes and no misspelled words.
4. Use lettering devices rapidly, accurately and with no spilled or smeared ink.
5. Place numerals, notes for dimensions, arrowheads, and title block lettering on drawings rapidly, neatly and with a high degree of legibility.
6. Change from one lettering style to another with no loss of efficiency.
7. Revise an existing pencil tracing and remove by erasing the dirt and grime that may have accumulated on the back side of the tracing.
8. Protect the drawing from loose graphite.
9. Conform to the standard shapes of letters and avoid alterations to develop a personal style.
10. Demonstrate a conscientious effort to steadily improve lettering skill.

Criterion-Referenced Measures:

The student must:

1. Create the recommended shapes of single-stroke, gothic letters, capital and lower case, and numerals, vertical and slanted.
2. Demonstrate an acceptable skill in making freehand pencil and inked letters.
3. Demonstrate an acceptable skill in using lettering devices--Leroy, Wrico, etc.
4. Practice the recommended rules for composing notes that are to be lettered on a drawing.
5. Exhibit a knowledge of all notes being oriented to read from the bottom of the drawing.
6. Practice the importance of legibility of letters and numerals.

USE OF EQUIPMENT

Performance Objectives:

The student who enters this level must be k owledgeable and highly skilled in using the basic equipment of a draftsman. He must know which equipment to choose, and he must use it rapidly and efficiently. The only new item of equipment introduced in LEVEL IV is the welding template used to quickly draw welding symbols (see the RAPIDESIGN No. 34 welding template).

Considerable irregular curve drawing is required in intersections and developments. The student should be able to use a conventional irregular curve and he should develop skill in using an adjustable irregular curve.

Criterion-Referenced Measures:

At the end of this unit the student must perform within an acceptable degree according to the instructor's standards, the following skills:

1. Handle all drafting equipment properly without dropping or damaging it.
2. Keep all equipment clean, adjusted and in first-class condition.
3. Arrange equipment for easy access.
4. Use any template rapidly and skillfully.
5. Use a conventional irregular curve for small and medium size curves.
6. Use an adjustable curve for large irregular curves.
7. Measure or lay off quantities quickly and accurately when using scales, protractors or other measuring devices.

DRAWING ABILITY

Performance Objectives:

Upon completion of this unit the student must perform within an acceptable degree, according to the instructor's standards, the following skills:

1. Develop the judgment to determine the orthographic views that are necessary to describe the geometry of a complicated machine part.
2. Apply the rules of dimensioning so that the size and location of each geometric feature of a part is clearly shown.
3. Intelligently select sections, partial views, auxiliary views, etc., to improve the clarity of a drawing.
4. Use the principles of revolution and true-length diagrams to get information required in making developments of surfaces.
5. Develop the surface of a part with the inside of the part facing the reader of the drawing.
6. Find the intersection between two surfaces.
7. Develop the surface of a sheet metal part showing the cutout area where another part intersects.

8. Demonstrate the ability to produce lines and letters that are of the proper density, size, neatness, etc.
9. Keep the drawing relatively clean and free of torn corners, etc.

Criterion-Referenced Measures:

The student must:

1. Select the best set of orthographic views to clearly describe the geometry of a part.
2. Apply the acceptable rules for dimensioning a part.
3. Use the following scales quickly and accurately: architect's, engineer's and metric.
4. Produce a tracing that will make acceptable prints.
5. Apply the principles of revolution in revolving a point, line, plane or solid about an axis of revolution.
6. Find the intersection between:
   a. Two objects bounded by planes
   b. Two objects with curved surfaces.
7. Develop the surface of a part showing the correct outline of the surface and any cut-outs in the surface.
8. Draw primary and secondary views.
9. Determine if a complete or partial view is satisfactory.
10. Determine if a complete surface development is required or if a one-half symmetrical view is adequate.
11. Skillfully use an irregular curve to produce curves that are accurate, smooth and of the same line quality as the straight lines on the drawing.

DIMENSIONING

Performance Objectives:

Upon completion of this unit the student must perform within an acceptable degree, according to the instructor's standards, the following skills:

1. Use the dimensioning practices described in ANSI Y14.5.
2. Use the dimensioning practices outlined in recently published textbooks on technical drafting.
3. Dimension the smallest details and those closest to the views first and work outward to the overall dimensions.
4. Place dimensions where the drawing best describes the detail being dimensioned.
5. Make an extra effort to be sure that the dimensioning is complete.
6. Determine limit dimensions, tolerances, clearances, etc., by proper use of ANSI B4.1 Limit Tables.
7. Use MACHINERY'S HANDBOOK to get correct dimensions and specifications on standard threads, fasteners, twist drills, etc.
8. Accept and use special dimensioning practices that are used in many industrial drafting situations.

Criterion-Referenced Measures:

The student must:

1. Demonstrate a knowledge of the existence of the ANSI Standard Y14.5 and how to interpret its provisions.
2. Describe the purpose of dimensioning which is to specify the overall size and the size and location of the geometrical features of a part or physical system.
3. Demonstrate a knowledge of the elementary shop processes and how to coordinate dimensioning with the production processes.
4. Specify that dimensions of mating parts must be coordinated to assure desired performance.
5. Acknowledge that drawings are frequently revised and extra care must be exercised to avoid costly mistakes related to dimensioning.
6. Specify that, regardless of extra caution, there is always a variation in the size of manufactured parts, and some problems can be avoided or reduced if the dimensioning is done with this fact in mind.
7. Explain that close tolerances and a high degree of precision will increase the cost of a part.
8. Demonstrate a working knowledge of mating dimensions by using them to check mating parts even though they may not appear on either part.
9. Specify tolerance limits according to bilateral and unilateral tolerances.
10. Specify the fit according to the use of the pieces.
11. Determine what machining process should be used to achieve that fit.
12. Specify finishes.
13. Specify welds.
14. Dimension holes evenly spaced and unevenly spaced around the bolt circle and locate the bolt circle where not given or use other methods to locate the holes such as coordinate dimensioning, using linear measurements, base lines or datums.

RELATED SUBJECTS

Welding

The student is introduced to the three welding processes and the five basic types of welded joints. The student also learns the four types of arc and gas weldback, fillet, plug and groove, as well as, the different types of groove--square, v, level, u and j, and the symbol for each. The four types of resistance welds and their symbols and the standard elements of a welding symbol, what each means and where it is located on the symbol, is also taught to the student.

Math - Plane and Solid Geometry

The student learns how to compute squares, square roots, areas and perimeters of surfaces as draftsmen would need them. Solid geometry dealing with volumes and surfaces of prisms and cylinders, pyramids and cones, spheres and rings is taught. Weights of castings and how to determine board measure is also covered.

RELATED SUBJECTS

WELDING

Performance Objectives:

Upon completion of this unit of related instruction the student must perform within an acceptable degree, according to the instructor's standards, the following skills:

1. Detail working drawings from orthographics, pictorials, sketches, models, actual objects and/or other assigned problems that will include welds, welded joints and other fabrication information.
2. Demonstrate a working knowledge of fusion and pressure welding in drawing assigned problems.
3. Look up welding symbols, the standard location of the elements of the symbols, the meaning of the symbols in the drafting standards, and the student will apply this reference material in drawing problems.
4. Identify basic types of welded joints on assigned drawing problems.
5. Identify fusion welds with symbols on assigned drawing problems.
6. Draw pressure (resistance) weld symbols on assigned drafting problems.
7. Use welding templates to draw assigned drafting problems.

Criterion-Referenced Measures:

The student must:

1. Define the following:
   a. Welding
   b. Fusion welding
   c. Gas welding
   d. Pressure welding
   e. Resistance welding
   f. Spot welding
   g. Seam welding
   h. Flash or upset welding
   i. Projection welding
   j. Forge welding
2. Identify the following:
   a. Basic types of welding
   b. Basic types of welding joints.
   c. Fusion welds and weld symbols.
   d. Supplementary symbols (weld all around, field weld, melt through and contours).
   e. The standard location of the elements of a welding symbol and the meanings of the symbol.

f. Types and sizes of welding templates.
g. Welding standards.
h. Occupational standards.

3. Use safe practices.
4. Read and interpret welding graphic representations.
5. Use mathematics applied to welding details.
6. Trace.
7. Apply the elementary principles of mechanical drawing and freehand sketching.
8. Reproduce drawings.
9. Detail welding problems assigned from written instructions oral instructions, actual objects, sketches and/or orthographic drawings.
10. Draw the basic types of welded joints, the different type welds, and the symbols for each.
11. Draw the supplementary symbols used in welding (weld all around, field weld, melt through and contours).
12. Locate the different elements of a welding symbol and indicate the correct graphic representations.
13. Use welding templates.

RELATED SUBJECTS

MATH - PLANE AND SOLID GEOMETRY

Performance Objectives:

Upon completion of this unit of related instruction the student must perform within an acceptable degree, according to the instructor's standards, the following skills:

1. Solve for the missing factor of a geometrical figure such as rectangle, triangle, or trapezoid when only two of its factors are given. The factors are length, width, perimeter, and altitude.
2. Calculate the volume of common geometric shapes.
3. Calculate the surface area of common geometric shapes.

Criterion-Referenced Measures:

The student must:

1. Compute the area of a rectangle.
2. Compute the perimeter of a rectangle.
3. Find the width or the length of a rectangle if the area and the other side are known.
4. Find the square and the square root of a number.
5. Find the missing side of a right triangle by means of squares and square roots.
6. Find the area of a right triangle
7. Find the area of an isosceles triangle.
8. Solve the area of a scalene triangle using Hero's formula.
9. Find the area of a trapezoid.

10. Solve the circumference of a circle, given the radius of diameter.
11. Solve the diameter of a circle, given the circumference.
12. Solve the area of a circle given the diameter or radius.
13. Find the area of a ring section.
14. Solve the length of an arc and the area of a sector given the length of the radius and the angle of the arc.
15. Find the volume of a prism.
16. Find the volume of a cylinder.
17. Find the lateral surface of a prism.
18. Find the volume of a cone.
19. Find the volume of a pyramid.
20. Find the lateral surfaces of pyramids and cones.
21. Find the volume of a frustrum of a pyramid and a cone.
22. Find the altitude of a frustrum of a pyramid and a cone.
23. Find the lateral surface of a frustrum of a pyramid and a cone.
24. Find the surface of a sphere.
25. Find the volume of composite solid figures.

JOB OPPORTUNITIES
LEVEL IV

	D.O.T. Code
Blueprinting-Machine Operator	979.782
Messenger	230.878
Blueprint Trimmer	920.887
Engineering Clerk and Drafting Clerk	249.281
Tracer-Draftsman, Junior	017.281
Draftsman, Commercial	017.281
Apprentice Layout Man	809.281
Apprentice Draftsman	007.281

L E V E L V

Purpose

The purpose of Level V is to give the student a quick look at the fields of drafting open to him in making his choice as to which field to enter, but also to teach him the basic essentials in each field. Most forms of drafting overlap in other areas. For example, the piping draftsman finds himself required to understand foundations and contours as a part of piping.

Level V is therefore a condensed version to take care of the Level V for each advanced level.

Beginning with Level VI, the student must choose his particular field and continue Levels VI, VII, and VIII in that field.

CURRICULUM

LEVEL V

	Suggested Time
Mapping	2 weeks
Unit 1 - Townships	
Unit 2 - Metes and Bounds	
Unit 3 - Contours	
Architecture	3 weeks
Unit 1 - Materials of Construction	
Unit 2 - Foundation	
Unit 3 - Floors, Walls, and Roofs	
Unit 4 - Electrical Systems	
Unit 5 - Air Conditioning	
Piping	2 weeks
Unit 1 - Familiarization	
Unit 2 - Fittings	
Unit 3 - Valves	
Unit 4 - Types of Drawings	
Unit 5 - Dimensioning	
Structural Steel	2 weeks
Unit 1 - Shapes and Sizes	
Unit 2 - Reading Plans	
Unit 3 - Framing	

RELATED SUBJECTS

Strength of Materials

Unit 1 - Types of Loads
Unit 2 - Yield Strength and Factor of Safety
Unit 3 - Design of Springs and Keys
Unit 4 - Use of Handbooks

MAPPING

Unit 1 - Townships

The student learns the divisions of land in Louisiana--townships, sections and quarters and about the Louisiana Base Line, Louisiana Meridian and where each are located. The student also learns dimensions and acreage of each division, how to draw a plat from a legal description using engineer's scales, and to letter using lower case--vertical and slant lettering.

Unit 2 - Metes and Bounds

The student is taught how to draw a plat when given dimensions and angles and how to determine inside angles of the plat and check for closing.

Unit 3 - Contours

The student learns how to draw contour lines and establish elevations on a plat by working from grids.

Performance Objectives:

Upon completion of this unit the student must perform within an acceptable degree, according to the instructor's standards, the following skills:

1. Work from a legal description which gives townships, sections, and divisions of the section and make an ink drawing of the plat at a large enough scale for the engineer to work from. A point of beginning is to be established, dimensions are to be given, and acreage is to be figured. If practical, a vicinity map is to be drawn.
2. Draw a plat giving lengths of sides and the degrees that the side is bearing off due north or south.
3. Calculate inside angles and check totals for closure.
4. Plot assigned points, such as wells, on a township given directions from the center point or a particular corner of a section or portion of a section.
5. Plot contour lines from a grid of a piece of property giving ground elevations.

Criterion-Referenced Measures:

The student must:

1. Lay out a township and divide it into sections numbering the sections in the correct order.
2. Demonstrate knowledge of the dimensions and acreage of a township, section, quarter-section, quarter-quarter-section and quarter-quarter-quarter-section.
3. Use all six scales on the engineer's scale using them for hundreds and thousands of feet (1" = 5000').
4. Make all drawings in ink.
5. Locate the Louisiana Base Line and the Louisiana Meridian and explain the meaning of each.
6. Locate points accurately in the township by reference to quarter-sections, etc.
7. Draw a plat from a legal description giving the length in hundredths of a foot rather than inches, and direction in degrees and minutes bearing off north and south, of each

side and proceeding in one direction, preferably clockwise, from the point of beginning back to the point of beginning.

8. Determine inside angles of the plat and check for closure.
9. Lay out a grid on a piece of property and determine the contour lines from the ground elevations of the grid corners.

ARCHITECTURE

Unit 1 - Materials of Construction

The student learns concrete--what it is composed of, how strong it is, how it can be tested, how it can be strengthened, and how it can be harmed. Other materials covered include: reinforcing, its purpose, bonding, and strength, and wood which involves its characteristics, grading, strength, and sizes.

The student also learns about masonry--types of brick, sizes of brick, mortar joints, reinforcing, and cleaning and about structural clay tile, concrete blocks, and cast stone.

Unit 2 - Foundations

The student is taught the various types of foundations--monolithic, spread, pier, underreamed (bell), piling and how to detail the reinforcing steel--allowance at sides and bottom, stirrups, dowels, and ties. The student learns how the foundation is constructed and that the building of the foundation must be planned before it can be drawn.

Unit 3 - Floors, Walls and Roofs

The student is introduced to concrete and wood floor construction and about the different types of wall construction--frame, brick veneer, and solid masonry, and the advantages and disadvantages of each.

The student also learns different types of roof construction--wood, steel and concrete and how they are built, flat or with a pitch and the common types of roof trusses.

The student is taught how to draw a simple wall section for a commercial building--monolithic foundation and slab, 12" masonry wall, steel joist, and concrete roof slab.

Unit 4 - Electrical Systems

The student is introduced to the National Electrical Code and other applicable electrical codes and how to coordinate these codes in developing the electrical system of a structure. The student learns electrical symbols and how they are located on a plan.

Unit 5 - Air Conditioning Systems

The student is taught the basic principles of air conditioning and how to design the air conditioning system for a residential structure.

Performance Objectives:

Upon completion of this unit the student must perform within an acceptable degree, according to the instructor's standards, the following skills:

1. Draw illustrations of building materials, such as concrete, wood, and masonry to include sizes, uses and limitations.
2. Draw foundations correctly showing the reinforcing steel in the correct location.
3. Demonstrate a knowledge of how foundations are constructed.
4. Draw a section through a woodframed floor showing proper construction.
5. Discuss various types of wall construction.
6. Demonstrate a knowledge of roof construction using wood, steel and concrete.
7. Demonstrate an understanding of the basic principles of electricity and be able to solve problems in electricity as applied to elementary structures.
8. Identify electrical symbols and use them on a drawing.
9. Demonstrate an understanding of air conditioning principles by designing and drawing a simple layout.

Criterion-Referenced Measures:

The student must:

1. Demonstrate the knowledge of the basic facts about concrete--how the cement is made, how concrete is made, the proportions of aggregate and cement to use for a desired result, how much water to use, how to test concrete, what additives to use and for what purpose, initial set, final set and strength of concrete.
2. Demonstrate the knowledge of reinforcing steel--shapes, sizes, bonding, strength, lapping, and bending.
3. Demonstrate the knowledge of wood used as structural members--nominal and true sizes, species, strength, grading and characteristics.
4. Identify masonry--types of brick, nominal and actual sizes, mortar joint sizes, bonding, reinforcing, cleaning, other types of masonry such as structural clay tile, concrete blocks and cast stone.
5. Draw various types of foundations, such as monolithic footing and slab, spread footing supporting foundation walls, spot footings supporting piers or columns, and underreamed footings supporting beams.

6. Draw reinforcing steel in the above footings, dimensioning it and showing stirrups, dowels and ties if required.
7. Demonstrate a clear understanding of how foundations are to be built--machinery required, form construction, bracing, fill, and waterproofing.
8. Demonstrate the knowledge of concrete slab construction suspended as well as on the ground, the different way of reinforcing each and why, and how to waterproof slabs.
9. Draw a section through a wood floor showing joists and subfloor resting on a sill or masonry wall.
10. Demonstrate an understanding of the most common types of wall construction--frame, brick veneer and solid masonry, identifying advantages and disadvantages of each.
11. Demonstrate an understanding of different types of roof construction--wood, steel and concrete or a combination.
12. Demonstrate an understanding of how to flash roofs to keep out water.
13. Demonstrate an understanding of a roof pitch and how much slope to put on a flat roof.
14. Demonstrate an understanding of the different types of trusses--fink, kingpost, scissors, howe, and bow.
15. Demonstrate an understanding of pre-stressed and post-stressed concrete.
16. Draw a simple masonry wall section.
17. Demonstrate an understanding of the basic principles of electricity and be able to work problems using the formulas.
18. Demonstrate an understanding of electrical symbols.
19. Draw electrical symbols on a floor plan.
20. Demonstrate an understanding of the basic principles of air conditioning and be able to design a system for a simple house.

PIPING

Unit 1 - Familiarization

The student is familiarized with the purpose of piping systems in a production process and in structures such as homes, office buildings, schools and those in industry to include: chemical plants, power plants, refineries and carbon black plants. The student surveys the various types of piping and their uses--ferrous, non-ferrous, plastic and ceramic and the importance of reference information on standard specifications, sizes and weights--ASTM (American Society for Testing and Materials), ANSI, API (American Petroleum Institute), etc.

Unit 2 - Fittings

The student learns about the various ways of joining pipe, fittings, valves, and systems components, (screwed, welded, flanged, etc.) and the graphical symbols for single line pipe drawings. Pipe thread specifications and graphical symbols for threaded pipe and fittings are also covered.

Unit 3 - Valves

The student is introduced to the various types and uses of valves such as gate, glove, plug, relief, and the graphical symbols for each. The student is taught the importance of specifying the correct orientation of valves that must be coordinated with the direction of fluid flow--check valves, globe valves, safety relief valves, etc., and the importance of accumulating manufacturers' catalogs of specifications and other technical information about valves.

Unit 4 - Types of Drawings

The student learns how to draw single-line developed drawings, single-line multiview orthographic drawings and single-line free-hand pictorial (isometric and oblique) sketches of piping systems. The student also learns about double-line multiview orthographic drawings of piping systems.

Unit 5 - Dimensioning

The student is taught how to dimension single-line developed, single-line multiview orthographic, single-line pictorial and double-line multiview orthographic piping drawings.

Performance Objectives:

Upon completion of this unit the student must perform within an acceptable degree, according to the instructor's standards, the following skills:

1. Find technical specifications and dimensions of standing grades of ferrous, non-ferrous, plastic and ceramic pipe and fittings.
2. Recognize the graphical symbols for pipe fittings and valves.
3. Identify and be able to use graphical symbols which are used to indicate how pipe, and pipe fittings and valves are connected.
4. Make a single-line developed drawing working from a pictorial sketch; make a single-line multiview orthographic, or a double-line multiview orthographic pipe drawing, all of relatively simple piping systems.
5. Make a single-line multiview orthographic drawing working from a pictorial sketch.
6. Draw and dimension single-line pictorial, single-line developed and single-line multiview orthographic piping drawings.
7. Identify and interpret mechanical flow sheets.
8. Use flow sheets, structural drawings, equipment lists, and pipe layouts.

Criterion-Referenced Measures:

The student must:

1. Demonstrate the knowledge of the terminology of various types of piping drawings--single-line developed, single-line multiview orthographic, pictorial, and double-line multiview orthographic.
2. Demonstrate the graphical symbols for pipe fittings, valves and the various methods of connecting these.
3. Identify sources of information required in making piping drawings.
4. Demonstrate the knowledge of valves which must be oriented according to the direction of fluid flow.
5. Demonstrate the knowledge of dimensioning elementary piping drawings completely so a contractor could fabricate and install the piping system.

STRUCTURAL STEEL DRAFTING

Unit 1 - Shapes and Sizes

The student learns shapes of steel using the AISC (American Institute of Steel Construction) Manual and how to use the tables provided in the manual.

Unit 2 - Reading Plans

The student is taught how to determine the information needed about a particular beam by reading the engineer's plans--the size, the shape, the length, the location of the top in relation to the pieces connected to it. Other information covered includes; size of the pieces connected, where they are connected and how, and how many of each are needed.

Unit 3 - Framing

The student learns how to frame beams into each other allowing for construction, coping, determining reactions for uniformly distributed loads, and determine from the manual determine how many bolts to use for the connection and gauges.

Performance Objectives:

Upon completion of this unit the student must perform within an acceptable degree, according to the instructor's standards, the following skills:

1. Demonstrate familiarity with the various shapes of steel.
2. Demonstrate familiarity with the tables in the AISC Manual.
3. Detail a steel beam framed between two other beams showing coping, actual length of beam and bolted connections.

Criterion-Referenced Measures:

The student must:

1. Use the tables in the AISC Manual to obtain information needed as to shape, description, size, weight, a, k, g_1, c, and g distances, allowable uniform loads for beams, allowable loads for shear and bearing for framed beam connections, etc.
2. Determine the length of a beam by taking the span and subtracting the width of the members framed into.
3. Determine if coping is needed and the dimensions of the cope.
4. Determine reactions for uniformly loaded beams from the tables.
5. Determine how many bolts are needed.
6. Detail a steel beam showing the length, coping and bolts.
7. Read welding symbols used in structural steel detailing.
8. Demonstrate an understanding of methods of forming standard shapes and economy of using readily available shapes.

LEVEL V CURRICULUM

RELATED SUBJECTS STRENGTH OF MATERIALS

Prerequisite - completion of math for four levels with at least a "B" average.

Unit 1 - Types of Loads

The student learns the three basic types of stresses that construction materials are subjected to--tension, compression and shear. The student also learns how to compute the unit stress for a given load and given size cross-section.

Unit 2 - Yield Strength and Factor of Safety

The student learns about the behavior of materials under load, the strength properties of materials up to the yield strength, how to use a safety factor in selecting the size of a member to support a given load, and how to determine the factor of safety in a given sicuation.

Unit 3 - Design of Springs and Keys

The student is introduced to Hooke's Law and Poisson's Ratio, the change in dimensions of a structural member when subjected to tensile or compressive loads. The student learns about a spring constant, the force required to depress or stretch a spring one unit of distance and how to compute the deflection of a spring of given constant and subjected to a given load. The student also learns about shear stresses and how to compute the unit shear stree under given load. Torsion and how to select the shaft size and key size for transmitting a specified horsepower load are also covered.

Unit 4 - Use of Handbooks

The student learns how to use well-known handbooks to find information on:

a. Strength data of materials (metals, plastics and wood)
b. Stresses in machine parts
c. Stresses a deflections of beams
d. Design of columns

Performance Objectives:

Upon completion of this unit of related instruction the student must perform within an acceptable degree, according to the instructor's standards, the following skills:

1. Compute the stress in pounds per square inch for tension, compression and shear, given the total load and the geometry of the cross-section supporting the load.

2. Determine the size of cross section in square inches required to support a given load if the allowable stress is indicated.
3. Determine the allowable stress in pounds per square inch when the yield strength in pounds per square inch is given and the factor of safety is given.
4. Determine the factor of safety if the yield strength is given in pounds per square inch and the total load and cross-section are given.
5. Determine how much a machine part or structural member stretches (or contracts) when subjected to tension or compression and a change in temperature.
6. Determine how much a spring compresses or elongates if the load is known and if the spring constant is known.
7. Determine the shaft size and key size for transmitting a specified horsepower load under specified conditions.
8. Apply empirical equations found in Machinery's Handbook (42) to determine stresses in machine parts.
9. Apply empirical equations found in Machinery's Handbook (42) and in the Manual of Steel Construction of the American Institute of Steel Construction (40) to determine stresses and deflections of beams under load.
10. Apply empirical equations to determine the size of a column to support a specified load.

Criterion-Referenced Measures:

The student must:

1. Make calculations using a portable electronic calculator or an office calculator.
2. Compute quickly and accurately the area of a circle and the area of any polygon.
3. Find cross-sectional dimensions, areas, etc. of standard structural members.
4. Find strength data for specified materials quickly and accurately.
5. Use a safety factor in selecting the size of a part to support a load.
6. Apply Hooke's Law and Poisson's Ratio Law to compute changes in dimensions of a part that is supporting a load.
7. Demonstrate knowledge of a spring constant and how to use it.
8. Select a shaft to transmit a specified horsepower load and base the decision on allowable stress and total allowable angular deflection or on allowable stress only.
9. Apply handbook equations for sizing columns and computing stresses and deflections of beams.

LEVEL V CURRICULUM

RELATED SUBJECTS USE OF TRANSIT

Prerequisite - completion of math for first four levels with at least a grade of "B".

Unit 1 - Familiarization

The student is familiarized with the typical engineer transit, its components, measuring scales, compass, adjustments, etc., and proper care of the equipment.

Unit 2 - Field Notes

The student learns about the skill, neatness, accuracy and importance of recording field notes and sketches when performing transit work.

Unit 3 - Voice and Hand Signals

The student is taught how to communicate over considerable distances with other members of a surveying party using voice and hand signals.

Unit 4 - Setting Up the Transit on a Tripod and Adjusting for Use

The student learns how to mount the transit on a tripod, place the tripod loosely over a station mark, attach a plumb bob, firmly set the tripod with plumb bob accurately located over the station mark, and accurately adjust the transit level on a horizontal plane. The importance of accurately setting the transit over the station mark is emphasized.

Unit 5 - Determining Horizontal and Vertical Angles with a Transit, Range Pole and Tape

The student learns how to use the horizontal and vertical circles and their verniers for determining horizontal and vertical angles, repetition of measurements for improved accuracy, and use of the range pole and surveyor's tape.

Unit 6 - Use of Transit as a Level.

Leveling Rod

The student is taught how to use a transit as a level for differential leveling and about the scales and vernier on a leveling rod.

Performance Objectives:

Upon completion of this unit of related instruction the student must perform within an acceptable degree, according to the instructor's standards, the following skills:

1. Exercise extreme care at all times in handling, transporting and storing a transit and the associated devices used with it.
2. Assemble a transit on a tripod and accurately set and level the transit over a station mark.
3. Use voice and hand signals in communicating with other members of a surveying party.
4. Use the transit to measure an existing angle in a vertical plane or to lay out a specified angle in a vertical plane.
5. Measure an existing angle in a horizontal plane or lay out a specified angle in a horizontal plane.
6. Measure or lay out an angle in a horizontal plane when the angle is specified with respect to magnetic north.
7. Perform differential leveling between two points.
8. Use any transit and perform measurements with the maximum degree of accuracy designed into the transit.
9. Exercise extreme care in recording field notes and sketches that are accurate, complete, legible and neat.

Criterion-Referenced Measures:

The student must:

1. Demonstrate the knowledge of what information is required in field notes for a transit job.
2. Keep field notes using a relatively hard grade drafting pencil and good quality field book and not erase mistakes in data but draw a line through erroneous values and record correct values. Not transcribe field notes, but record them as the job is being done.
3. Demonstrate the knowledge of the harmful effects of rough treatment, extreme temperatures and strong magnetic fields on the transit.
4. Read the circles, verniers and compass on a transit with consistent accuracy.
5. Demonstrate ability in addition, subtraction and use of trig tables to accurately process the data gathered from a transit job.
6. Demonstrate the knowledge of the correct procedure to repeat measurements in a horizontal place to improve accuracy.
7. Demonstrate the knowledge of how to guard against personal errors and instrument errors. For example, the student must know that an angle in a vertical plane may be read with the telescope both direct and reversed.

8. Demonstrate the commonly accepted words and hand signals used in communicating with other members of a surveying party.
9. Read the scale and vernier on a leveling rod accurately.

JOB OPPORTUNITIES AFTER LEVEL V

	D.O.T. Code
Blueprinting-Machine Operator	979.782
Messenger	230.878
Blueprint Trimmer	920.887
Engineering Clerk and Drafting Clerk	249.281
Tracer-Draftsman, Junior	017.281
Draftsman, Commercial	017.281
Apprentice Layout Man	809.281
Apprentice Draftsman	007.281
Draftsman, Heating and Ventilating	017.281
City Planning Aid	119.388
Refrigeration Draftsman	017.281
Reinforced Concrete Draftsman	005.281

LEVEL VI

PIPING

At this level the student is introduced to such information as, pipe thread specifications and graphical symbols, graphical symbols for other methods of joining pipe (welded, bell and spigot, etc.), dimensions and weights of standard pipe and fittings, catalog and standard information on dimensions of fittings, valves, tube-turns, etc., and double-line, multiview, and orthographic drawings with dimensions.

Performance Objectives:

At the completion of this level the student must perform within an acceptable degree, according to the instructor's standards, the following skills:

1. Make single-line and double-line orthographic pipe drawings having screwed, welded, flanged, soldered or bell and spigot fittings.
2. Dimension double-line orthographic piping drawings accurately and completely.
3. Locate detailed information on dimensions and weights of pipe, pipe fittings, valves and other standard components that might be in a piping system.
4. Assist the engineer in making decisions on which portions of a piping system should be shop fabricated and which should be fabricated on the job.
5. Prepare a single-line drawing and specifications for sanitary water systems, drains, and sewers that conform to all applicable laws and codes.

Criterion-Referenced Measures:

The student must:

1. Demonstrate that piping drawings may be drawn single-line or double-line in multiview orthographic or in pictorial (isometric or oblique).
2. Identify on a test the names and graphical symbols for all standard pipe fittings. Minimum score to be outlined by the instructor.
3. Find and compute the dimensions and weights of standard pipe and standard pipe fittings.
4. Identify the different types of valves and the graphical symbols for each.
5. Dimension piping drawings.
6. Identify the different methods of joining pipe and fittings (screwed, welded, socket-welded, flanged, etc.) and the graphical symbols and technical specifications for each.

7. Find the technical specifications and graphical symbols for all screw threads involved in piping.
8. Use flow sheets, structural drawings, equipment lists, and pipe layouts.

LEVEL VII

PIPING

At this level the student is introduced to such information as, process and mechanical flow charts, graphical instrument symbols, isometric and oblique single line piping systems, electric motor operated valves and other control valves, dimensioning and notations for flow charts and pictorial piping drawings.

Performance Objectives:

Upon the completion of this level the student must be able to perform within an acceptable degree, according to the instructor's standards, the following skills:

1. Identify and use most of the basic instrument symbols and abbreviations as adopted by the Instrument Society of America.
2. Follow instructions, oral or written, from process designer and prepare schematic process flow charts indicating all instruments and process components.
3. Draw double-line multiview orthographic drawings of special piping arrangements for such things as straightening vanes for flow meters.
4. Use the ANSI B31.1 Code for pressure piping for selecting pipe for pressure and temperature.
5. Select gasket material that will not blow out nor react chemically with the fluid in the pipe.
6. Find the thermal coefficient of expansion of pipe material and compute the elongation of a length of pipe.
7. Select, specify and draw expansion joints and expansion loops.
8. Find technical information about protective coatings and insulation for corrosion protection, heat loss (or gain) and to prevent undesired sweating.
9. Find information on flange dimensions and flange bolts, nuts and washers.
10. Design a piping system with necessary support to prevent unwanted forces on process components (pumps, vessels, etc.) and provide freedom for expansion of the piping system.
11. Demonstrate when and how to specify pipe sleeves.
12. Specify drains, drips and traps.
13. Compute the weight of the liquid in a piping system.
14. Compute the hoop stress in piping.

Criterion-Referenced Measures:

The student must:

1. Work with a team of process designers to develop a flow chart for each piping system. The student must learn standard flow chart for each piping system. The student must learn standard flow chart symbols for pumps, vessels, heat exchangers, reactors, etc., plus most of the graphical symbols for process instrumentation.
2. Sketch and draw isometric and/or oblique single-line piping drawings showing all process components, valves, fittings, dimensions and any technical specifications required by the process designer.
3. Sketch and draw single-line instrumentation flow charts showing complete and accurate symbols for each instrument in a piping system.
4. Draw detailed double-line instrument piping drawing for special hook-ups as required by the instrument engineer.
5. Make a material take-off for all fittings, pipe, valves, instruments, etc. for a piping system. Estimate the total weight of pipe, valves and fittings.

LEVEL VIII

PIPING

At this level the following information is introduced: location of valves for operation and maintenance, pipe hangers, anchors, guides and supports, thermal expansion, protective covering and coatings for moisture, thermal and corrosion, painting color codes for piping systems, prefabricated pipe, ASTM specifications for piping materials, plumbing specifications and sewer systems.

Performance Objectives:

Upon the completion of this level the student must perform within an acceptable degree, according to the instructor's standards, the following skills:

1. Coordinate the physical location of the piping and instrumentation system with overall plant maintenance (example, in pipe trenches or overhead so vehicles may move in and out).
2. Demonstrate the reason for hand operated valves being located for easy operation and maintenance.
3. Check maximum extension of valve stems to prevent interference.
4. Check with process designer to provide by-passes around system components if component fails.
5. Design provisions for safe exhaust piping for dangerous fluids and gases.

6. Identify and demonstrate the codes governing the installation and operation of relief valves.
7. Prepare drawings and specifications for specifying shop fabrication of piping.
8. Administer commonly required tests for piping systems.
9. Prepare piping drawings for sanitary water systems, drains and sewers so that all codes, laws, etc. are adhered to.
10. Use the ANSI Standard Scheme for the Identification of Piping Systems, ANSI A13.1-1956.
11. Provide drains for all piping and vessels that would not otherwise drain when taken out of service.

Criterion-Referenced Measures:

The student must:

1. Plan the location of all required valves and instruments in a piping system so that human operators and maintenance workers would have the best access for routine operation and maintenance and for all safety considerations.
2. Assist the piping engineer in the selection and location of all anchors, guides, hangers, supports, expansion joints, expansion bends and loops, etc., to assure that the piping system will not exert unwanted forces on system components (pumps, heat exchangers, vessels, etc.), yet, will be sufficiently free to contract and expand without creating unwanted stresses in the piping system.
3. Select and specify coatings and coverings for protection against corrosion, heat loss, refrigeration loss and moisture condensation and freezing.

CURRICULUM

ARCHITECTURE

Level VI

Unit 1 - Plot Plans
Unit 2 - Foundation Plans and Footing Details
Unit 3 - Eave Details and Roof and Ceiling Framing Plans
Unit 4 - Window Details and Elevations
Unit 5 - Floor Plans and Schedules
Unit 6 - Cabinet Drawings and Millwork

Related Subjects: Strength of Materials Level VI
Specifications
Methods of Construction

Level VII

Unit 1 - Fireplaces
Unit 2 - Stairs
Unit 3 - Two-Story Houses
Unit 4 - Basements
Unit 5 - Split-level Houses

Related Subjects: Strength of Materials Level VII
Specifications

Level VIII

Unit 1 - Small Store Buildings
Unit 2 - Warehouses
Unit 3 - Multi-story Buildings

Related Subjects: Strength of Materials Level VIII

LEVEL VI

ARCHITECTURE

Unit 1 - Plot Plans

The student learns how to draw plot plans and how to locate the house in proper positions to show related architectural features such as walks, drives, streets and patios. The student is taught how to establish existing grades from contour maps, to determine finish grades indicating swales if needed, and how to show the roof plan on the plot plan.

Unit 2 - Foundation Plans and Footing Details

The student learns how to draw a footing detail for a monolithic foundation beam and slab, both frame and brick veneer. The student also learns to draw foundation plans for frame and brick veneer houses, both conventional framing and trussed rafter construction, and to detail the different footings as they occur, garage, carport, exterior of house, carport-house, etc.

Unit 3 - Eave Details and Roof and Ceiling Framing Plans

The student is taught how to draw eave details for frame and brick veneer houses. The student is also taught ceiling framing, how to determine bearing partitions, how to box around openings, how to determine size and spacing of joists, and how to frame joists for hip roof. Roof construction to include; how to frame into ridges and valleys, barge rafters, gable construction, and hip construction is also covered. The student learns how rafters and joists fit together, how they are to be braced, how they will bear on the walls and how trussed rafter and conventional framing differ.

Unit 4 - Window Details and Elevations

The student learns to draw wood double hung and aluminum single hung windows, both in frame and brick veneer walls and how to draw elevations combining previous knowledge in order to get the proper finish floor elevations above the ground, the correct window head height and the correct trim around the windows and doors.

Unit 5 - Floor Plans and Schedules

The student learns the proper procedure for laying out a floor plan in order to minimize errors and improve speed in laying out walls, plumbing, cabinets, doors, windows, heaters, etc. to scale. The student is required to find the correct sizes and demonstrate the correct method of dimensioning in order to properly lay out the electrical system, framing, notes and titles,

and schedule doors and windows. The student is encouraged to check work constantly and is taught how to figure the area of the house.

Unit 6 - Cabinet Drawings and Millwork

The student is taught how to draw cabinets--both isometric and orthographic, determining how much space to provide for appliances, how much drawer space, shelf space and counter space is needed. The student learns basic millwork cuts and how to detail a cabinet.

Related Subjects:

Strength of Materials Level VI: Optional

Specifications: The student learns how to fill in a set of FHA specifications.

Methods of Construction: The student is assigned a house under construction and makes a report on the progress done each week--what trades are working and a description of what they are doing.

LEVEL VI

ARCHITECTURE

LETTERING

Performance Objective:

Upon completion of this unit the student must perform within an acceptable degree, according to the instructor's standards, the following skills:

1. The student must letter in a manner that is pleasing to the eye. His notes and dimension must be all the same height and must be arranged in a consistent manner. His titles must be complimentary to the drawing.

Criterion-Referenced Measures:

The student must:

1. Letter with a high degree of proficiency.
2. Letter upper case vertical and slant lettering.
3. Draw title centered below each drawing with the title large and the scale for that drawing smaller below it.
4. Make titles look better by underlining title or by making first letter larger or any similar act to improve the appearance.
5. Wherever several notes are together, student must line them up on the left side for a more uniform appearance.

6. Place all notes on the plans the same size--only titles are a different size.
7. Place all dimensions above the dimension line. Notes pertaining to them should be continued below the line.

USE OF INSTRUMENTS

Performance Objectives:

Upon completion of this unit the student must perform within an acceptable degree, according to the instructor's standards, the following skills:

1. A student must be able to use a template in a workmanlike manner making circles round and with even lines.
2. A student must demonstrate technique of drawing plumbing fixtures with a template so they are not crowded.
3. A student must be able to draw doors and door swings using a template.
4. A student must be able to use all the scales on the architect's scale. He is not permitted to convert from one scale to another but must use the specified scale.

Criterion-Referenced Measures:

Additional instruments used at this level are: House plan templates with plumbing, doors and circles.

The student must:

1. Use different sized circles for--(a) convenience outlets, (b) lights, and (c) bubbles for door and window symbols.
2. Demonstrate knowledge on sizes of fixtures and appliances so enough space will be left around template openings for object to work--such as tub or sink. Most templates show wall line. Student must be able to check for accuracy.
3. Understand and be able to draw proper way to swing doors.
4. Draw electrical switch lines using a french curve and show the line as a center line.
5. Use all the scales on the architect's scale.

DRAWING ABILITY

Performance Objectives:

Upon completion of this unit the student must perform within an acceptable degree, according to the instructor's standards, the following skills:

1. Draw a plot plan showing, labeling and dimensioning all architectural features with the exception of dimensioning the building, showing existing drainage and drainage as it will be when the building is completed, and all restrictions and easements.

2. Draw a complete wall section through a house giving all dimensions and noting all parts.
3. Draw a foundation plan giving all directions, dimensions, etc. on how to build it.
4. Draw window details showing how a prefabricated unit is installed and trimmed out.
5. Draw elevations for a house, representing all elements as they are to be actually built.
6. Draw a floor plan giving complete instructions for building. All work is to be strictly to scale.
7. Draw cabinet details allowing for all construction requirements and arranging the doors and drawers in a pleasing manner.

Criterion-Referenced Measures:

The student must:

1. Draw a plot plan accurately to a scale of 1" = 20'-0".
2. Locate house on property within restrictions--looking up restrictions if necessary. Easements must be shown.
3. Draw driveways, walks, porches, patios, streets, etc., correctly.
4. Show roof plan on building depicting building line below overhang.
5. Show existing grades and determine finish grades and elevation of floor slab and carport slab.
6. Give title and scale of plot plan and location of property and North arrow.
7. Draw a complete wall section through the house giving dimensions and naming essential parts.
8. Draw a foundation plan to a scale of 1/4" = 1'-0". Plan is to show any offsets, changes in elevation and foundation beams. Plan is to be fully dimensioned and fully noted. Dimensions are to box the building and notes are to describe the construction.
9. Draw window details for wood double hung and aluminum single hung windows in brick veneer and frame houses. Emphasis is to be on construction--how prefabricated units are connected to the structural members and how the construction is finished out with trim, sill, brick moulds, flashing, caulking.
10. Draw elevations for an assigned plan showing finish grade, finish floor elevation, window head, ceiling height, roof pitch. All details are to reflect what the student has learned in previous assignments about eaves, window trim, etc.
11. Draw a floor plan accurately with all appliances, plumbing, windows, doors and walls to scale. Dimension must go all the way through and either include wall thicknesses or be laid out in such a manner as to provide for them. All walls must be located. Special features must be fully dimensioned. Electrical outlets switches, gas and water

outlets must be shown. Notes must label everything shown. Ceiling framing is to be shown in the form of notes. (This replaces ceiling framing plan except in very unusual circumstances). Beams supporting joists must be labeled. Rooms must have titles and there must be a "Floor plan" title below the drawing. Bubbles will be shown for door and window symbols and schedules will be placed beside the drawing including the identification number, size of the unit and description of the unit. Number of each size may be included. All notes are to be the same size.

12. Draw cabinet elevations showing the design by which they are to be built. Toe space, stiles, drawers, counter tops, built-ins, are to be drawn to scale. Drawings may be isometric or orthographic and must be dimensioned overall. A student must draw construction, etc. If desired, student can show millwork edges and finishes for a more complete understanding of the unit.

DIMENSIONING

Performance Objectives:

Upon completion of this unit the student must perform within an acceptable degree, according to the instructor's standards, the following skills:

1. Draw dimension lines correctly showing fractions with an overall height as a whole number.
2. Depict foot and inch marks correctly.
3. Place necessary dimensions so the carpenter does not have to do any calculations.

Criterion-Referenced Measures:

The student must:

1. Draw dimension lines without a break and place dimensions above the line.
2. Show the slash between fractions as a diagonal so that fractions are almost the same overall height as the whole numbers.
3. Place a dash line between the feet and inches and show both foot and inch marks.
4. Carry dimension lines all the way through, with no omissions, so the carpenter does not have to do any calculations.
5. Box the dimensions around the building repeating overall dimensions on all four sides.
6. Repeat any dimension that is important on every drawing affected. The workman looks only at the one drawing he is using.

7. Dimension only to structural members. The finished material will not be in place.
8. Draw leaders using freehand--do not make line too long.
9. Draw floor plans at a scale of 1/4" = 1'-0".
10. Draw foundation plans and elevations at same scale as floor plan if space permits.
11. Draw cabinet details and room elevations at as large a scale as practical, such as 3/8" = 1'-0".
12. Draw wall sections at a scale large enough to show details but small enough to show complete section if required--3/4" = 1'-0" or 1" = 1'-0".
13. Draw details either 3" = 1'-0" of full scale depending on the size of the detail.
14. NOT use equilateral triangles for arrowheads.
15. Demonstrate an understanding that the lengths of the property lines are the dimensions given by the engineer and must be copied, not converted to feet and inches.
16. Demonstrate an understanding that the other dimensions on the plot plan are instructions to the carpenter and as such are readily understood in feet and inches.
17. Omit scale in the title block and show a title and scale under each drawing on the page.

LEVEL VII

ARCHITECTURE

Unit 1 - Fireplace

The student learns how to draw the plan of a fireplace and detail a section through it. The student must draw a complete set of working drawings to include; plot plan, foundation plan, floor plan, schedules, elevations, cabinet details, wall section, window details, and fireplace elevation and section but not showing ceiling framing plan, roof framing plan or millwork details.

Unit 2 - Stairs

The student is taught how to draw various stairs such as a straight run, stairs with a landing, stairs with limited headroom and how to anchor stairs at the top.

Unit 3 - Two-story Houses

The student is required to draw a complete set of working drawings for a two-story house including details of the stairs.

Unit 4 - Basements

The student learns how to detail basements to include methods of waterproofing and pier construction.

Unit 5 - Split-level Houses

The student is required to draw a split-level house, making one level frame into another. The student also plans for plumbing on three levels, roofs at different levels and foundations that must work together.

DRAWING ABILITY

Performance Objectives:

Upon completion of this unit the student must perform within an acceptable degree, according to the instructors standards, the following skills:

1. Detail a fireplace noting all parts and dimensioning fully.
2. Draw a set of working drawings for a one-story house on a concrete slab with a fireplace, given a sketch and plot plan.
3. Detail a stair section noting all parts and dimensioning fully.
4. Draw a complete set of working drawings for a two-story house allowing adequate space and arrangements for plumbing, air-conditioning and framing, given a sketch and a plot plan.
5. Draw a section of a building below grade providing adequate drainage and waterproofing.
6. Draw a complete set of working drawings for a split level house making all levels work together with stairs having adequate headroom, plumbing having adequate drainage, return and air supply for air conditioning worked out and framing details coordinated, given a sketch and plot information.

Criterion-Referenced Measures:

The student must:

1. Draw the plan, elevation and section through a fireplace. He must show the damper, smoke chamber and flue and note how they are fireproofed. He must show the firebrick in the fireplace opening and show the face brick covering it in the room. He must provide a foundation strong enough to support it. He must know that no structural wood is to be within 2" of the masonry. He must show how the chimney pierces the roof and how it is to be flashed to prevent leaks.
2. Given a sketch and plot information, the student must draw a complete set of working drawings, first checking the plot to see if the house will fit on it and then drawing in order the floor plan, schedules foundation plan, wall section, window and door details, fireplace details, elevations, cabinet elevations, special details and plot plan.

3. Draw plan and section (or elevation) of stairs showing distance from finished floor to finished floor, how many risers at what height, length of run, how many treads at what length and the stair construction. He must also know how to construct floor above to ensure adequate headroom. He must know how wide to make stairs and how to construct a landing. He must know how stairs are to be framed at head.
4. Draw a section through a two-story house.
5. Check the two-story house to make sure plumbing and air conditioning can be installed and framing is properly designed with stairs located at the same place on both levels, bearing partitions lined up and special features worked out.
6. Draw a foundation for pier construction using spot footings, masonry or concrete piers, and sill and joist construction or boxed joist or whatever is prevalent in the area.
7. Draw a wall section with the floor below finish grade, providing adequate drainage and waterproofing.
8. Draw sections through split level houses, making sure of plumbing, air conditioning, stairs and framing work. Stairs must have adequate headroom.

DIMENSIONING

Performance Objectives:

Upon completion of this unit the student must perform within an acceptable degree, according to the instructor's standards, the following skills:

1. Dimension fireplaces showing the proper ratio between opening size and flue sizes. Must demonstrate knowledge of the thickness of the masonry surrounding the opening and the type of masonry required.
2. Dimension stairs making all risers same height and all treads same width.
3. Dimension vertically-finish floor by whatever method is best to show the different floor levels and differences between ceiling and floor.

Criterion-Referenced Measures:

The student must:

1. Establish a zero elevation point (or 100'-0" or height above sea level or any convenient starting point) and have all vertical dimensions in the house work from that point.
2. Indicate dimensions of the elements of a fireplace--opening, depth, hearth, damper, smoke chamber, flue, height of chimney, location of mantel and the relation

each bears to the other.

3. Indicate dimensions for stairs--the relation between tread and riser, how to determine and show the exact height of the riser, how to check for headroom, the dimensions of the elements of a stair--stringer, riser, tread, nosing, rail.
4. Determine the distance between finish floors and the height of the window head on the second floor.
5. Determine ceiling heights on the second story or different levels of a split level.

RELATED SUBJECTS:

Strength of Materials: Level VII

Specifications:

The student learns more about FHA specifications--how to specify second story information, fireplace information, stair information and wood floor information.

Methods of Construction:

The student continues to visit jobs under construction.

LEVEL VIII

ARCHITECTURE

Unit 1 - Small Store Buildings

The student learns how to draw a small store building with a flat roof and a glass store front. The student studies the building codes to find out how many parking spaces are required, size requirements and other pertinent information.

Unit 2 - Warehouses

The student learns how to draw a masonry building with steel joists and lightweight concrete roof construction.

Unit 3 - Multi-story Building

The student studies multi-story building working drawings familiarizing himself with construction details and how the big sets of working drawings are set up with engineers doing some of the work and architects bringing the whole together.

RELATED STUDIES:

Strength of Materials: Level VIII

Specifications:

The student studies architect's specifications.

Use of Transit

LEVEL VIII

Performance Objectives:

Upon completion of this unit the student must perform within an acceptable degree, according to the instructor's standards, the following skills:

1. Draw a complete set of working drawings for a small commercial building with brick veneer walls, concrete slab floor, flat roof, wood construction, fixed glass in front.
2. Draw a set of working drawings for a warehouse with masonry walls, concrete floor, steel construction using steel joist to support the roof, lightweight concrete roof.
3. Make a report on the construction of a multi-story building from studying the plans.

Criterion-Referenced Measures:

The student must:

1. Draw a wall section for a small building using standard brick veneer walls on a monolithic concrete slab and a flat roof and must provide slope to roof and means to get water off. Must also detail fascia to provide a waterproof joint between wall and roof which is decorative.
2. Detail fixed glass windows in front of building using standard aluminum head, jamb and sill fittings.
3. Locate building on lot following building restrictions and lay out adequate parking according to the building code.
4. Draw a complete set of working drawings for a small store--brick veneer wall, concrete slab, wood roof joists, flat roof.
5. Draw a wall section for a building with 12" masonry walls, monolithic concrete slab, steel joists, lightweight concrete roof, suspended ceiling, flat roof and provide for drainage.
6. Lay out framing plan for warehouse type building with several bays with the steel joists supported by steel beams which are supported by columns.
7. Draw a complete set of working drawings for a warehouse type masonry building--concrete slab floor and roof, steel construction.

JOB OPPORTUNITIES AFTER COMPLETING LEVEL VIII

ARCHITECTURE

	D.O.T. Code
Blueprinting-Machine Operator	979.782
Messenger	230.878
Blueprint Trimmer	920.887
Engineering Clerk and Drafting Clerk	249.281
Draftsman, Commercial	017.281
City Planning Aid	199.388
Refrigeration Draftsman	017.281
Reinforced Concrete Draftsman	017.281
Structural Draftsman	005.281
Tile and Marble Draftsman	001.281
Architectural Draftsman	001.281
Technical Illustrator	017.281

MECHANICAL-MACHINERY

L E V E L V I

CURRICULUM

Unit 1 Threads
Unit 2 Fasteners
Unit 3 Weldments

RELATED SUBJECTS

Strength of Materials Level VI

Approximate length of time - 9 weeks

LETTERING

No change in this Level

USE OF EQUIPMENT

No equipment added

DRAWING ABILITY

Criterion referenced measures
Performance objectives

DIMENSIONING

No change at this level

RELATED SUBJECTS

Strength of materials

JOB OPPORTUNITIES

LEVEL VI

MECHANICAL - Machinery

Unit 1 - Threads

The student is taught how to draw and specify various types of threads and, in addition, types of screws, bolts and nuts. The student also learns how to detail bolts and nuts.

Unit 2 - Fasteners

The student is introduced to different types of keys, keyways, and pins. The student learns to detail springs, and where to find information about other types of fasteners.

Unit 3 - Weldments

Builds on the student's previous knowledge of welding by teaching him how to redesign castings into weldments and reasons for doing so. The student learns to calculate weights of weldments, specify finishes, and draw subassemblies of welded parts.

Performance Objectives:

Upon completion of this unit the student must perform within an acceptable degree, according to the instructor's standards, the following skills:

1. Draw and specify screws, bolts, and studs and the holes to receive them.
2. Draw and specify keys and keyways.
3. Demonstrate familiarity with other types of fasteners and be able to locate them in catalogs and describe their uses.
4. Make decisions as to which type of weld is best for a weldment and show it correctly on the drawing.
5. Draw a weldment to replace a casting and calculate the weight.

Criterion-Referenced Measures:

The student must:

1. Demonstrate knowledge of terms and descriptions of screw threads.
2. Demonstrate identification of the screw thread forms.
3. Draw a right-hand or left-hand thread.
4. Distinguish between single and multiple threads.
5. Draw schematic, simplified and detailed representation of internal and external threads.
6. Identify the series of threads and classes of fit for the old American National Thread and the new Unified threads.
7. Specify a screw.

8. Demonstrate by identifying the tables describing screws.
9. Differentiate between a bolt, stud and screw.
10. Relate the minimum engagement length of screws into different metals.
11. Draw and specify bolts and nuts.
12. Draw different types of keys and keyways.
13. Identify the different types of machine pins such as: taper pins, straight pins, dowel pins, clevis pins, and cotter pins.
14. Demonstrate the two classes of springs, helical and flat, and the three types of helical springs.
15. Draw springs.
16. Locate various types of fasteners with catalogs.
17. Make drawings of weldments with the proper symbols.
18. Make drawings changing castings to weldments.
19. Calculate weights of weldments.
20. Draw subassemblies of welded parts.

MECHANICAL-MACHINERY

LEVEL VII

CURRICULUM

Unit 1 Gears
Unit 2 Cams
Unit 3 Working Drawings

RELATED SUBJECTS

Strength of Materials Level VII

Math - Gears

Approximate length of time - 9 weeks

LETTERING

USE OF EQUIPMENT

DRAWING ABILITY

DIMENSIONING

JOB OPPORTUNITIES

LEVEL VII

Mechanical-Machinery

Unit 1 - Gears

The student is taught definitions and formulas and, in addition, to draw spur, bevel and worm gears with variations such as the rack. (Sources: 18 pages 595-604 and 28 pages 269-280).

Unit 2 - Cams

The student learns to draw displacement diagrams, typical curves, and become familiar with the two types of cams--radial and cylindrical. The student is taught the types of followers--pointed, roller, flat-faced and spherical and the location of followers--offset, not offset, pivoted. (Sources 28 pages 263-280).

Unit 3 - Working Drawings

The student learns to do complete working drawings including details and assemblies.

RELATED SUBJECTS: Strength of Materials Level VII
Math - Gears

The student learns to solve the formulas needed in compiling the information required to draw spur, bevel and rack gears.

DRAWING ABILITY

Performance Objectives:

Upon completion of this unit the student must perform within an acceptable degree, according to the instructor's standards, the following skills:

1. Draw a segment of a spur gear and pinion showing how the teeth mesh.
2. Prepare working drawings of a spur gear and pinion.
3. Prepare working drawings of a bevel gear and pinion.
4. Prepare working drawings of a spur gear and rack.
5. Prepare working drawing of a cam.
6. Prepare a complete set of working drawings for a multi-piece tool containing gears.

Criterion-Referenced Measures:

The student must:

1. Detail a segment of a gear and pinion showing the pitch circle, pressure angle, addendum circle, etc.
2. Draw a working drawing of a gear placing all the pertinent information for cutting the teeth in a chart and showing only the information needed for the gear blank.

3. Apply the data for a spur gear to a rack and draw the rack.
4. Make a working drawing of a bevel gear.
5. Make an assembly drawing of a bevel gear enclosed in a housing.
6. Demonstrate knowledge of the types of cams--radial and cylindrical.
7. Demonstrate an understanding of the basic principle of cams--a shaft turning an irregular shaped disc (cam) with a reciprocating plunger (follower) pressing a roller against it.
8. Draw a displacement diagram and be able to draw the typical curves for constant velocity, constant acceleration and harmonic motion.
9. Indicate the types of cam followers--pointed, roller, flat-faced and spherical-faced. (Sources: 28 page 264).
10. Demonstrate an understanding that followers can be offset, directly above or pivoted.
11. Draw a cam profile.
12. Identify component parts of a set of working drawings.
13. Draw a complete set of working drawings--assembly and detail which will meet the following requirements; each detail must have the detail number, the name of the detail, the number needed, the material, and heat treatment if required, a stock column on assembly sheet only, a title block for drawings showing name of the tool, part number, part name, drawn by, approved by, checked by, the date (same on all drawings), number of sheets in the job, the sheet number or drawing number or number of the tool. In addition the following are also frequently shown: the machine, the fixture it is used on, the number of the machine, the department that will use the tool, and the operation number.

DIMENSIONING

Performance Objectives:

Upon completion of this unit the student must perform within an acceptable degree, according to the instructor's standards, the following skills:

1. Dimension fully a set of working drawings including all the information necessary for the construction of the object.

Criterion-Referenced Measures:

Student must:

1. Fill in a chart on cutting data for spur gears.
2. Fill in a chart on cutting data for rack teeth.
3. Fill in a chart on cutting data for bevel gears.
4. Dimension a working drawing of a spur gear.
5. Dimension a working drawing of a rack.

6. Dimension a working drawing of a bevel gear.
7. Dimension a set of working drawings of a multi-piece project specifying tolerances fits and machine processes.
8. Indicate mating dimensions where necessary.

JOB OPPORTUNITIES AFTER LEVEL VI AND LEVEL VII

	D.O.T. Code
Blueprinting-Machine Operator	979.782
Messenger	230.878
Blueprint Trimmer	920.887
Engineering Clerk and Drafting Clerk	249.281
Tracer-Draftsman, Junior	017.281
Draftsman, Commercial	017.281
Apprentice Lay-out Man	809.281
Apprentice Draftsman	007.281
Draftsman, Heating and Ventilating	017.281
City Planning Aid	199.388
Refrigeration Draftsman	017.281
Reinforced Concrete Draftsman	005.281
Delineator	970.281
Black and White Draftsman	017.281
Patent Draftsman	007.281

LEVEL VIII

MECHANICAL - MACHINERY

Unit 1 - Miscellaneous details of jigs and fixtures

The student is introduced to the miscellaneous details of jigs and fixtures and their use at assembly.

Unit 2 - Clamping devices

The student is taught the various types of clamping devices.

Unit 3 - Drill jigs

The student learns the various types of drill jigs.

Unit 4 - Milling fixtures

The student is familiarized with the typical milling machine cuts and the types of milling fixtures.

Unit 5 - Sheet metal dies

The student learns about sheet metal dies.

Performance Objective:

Upon completion of this unit the student must perform within an acceptable degree, according to the instructor's standards, the following skills:

1. Detail a drill jig for drilling a hole in an assigned problem using parts when practical.

Criterion-Referenced Measures:

The student must:

1. Identify miscellaneous details of jigs such as: brace bar, link, rest V block, milling fixture key, knurled head screw, spring jack, jig foot, C washers, bushing plate, slide guide and gib, swivel screw, clamping V block, stud, shoulder screw or stripper bolt, bayonet lock, threaded bushing, diamond or two-point locator, swing bolt, quarter turn thumb screw, sperical washer and milling fixture clamp.
2. Describe the uses of the above details.
3. Demonstrate the uses of other clamping devices such as air cylinder operated clamp, clamp to hold three parts in a milling fixture, clamps with sliding jaws, clamps with notched jaws, equalizing clamps and double jaw clamps, etc.

4. Demonstrate knowledge of drill jigs and identify the procedure for designing a drill jig from studying the part through making design sketches through designing and making working drawings of the drill jig.
5. Demonstrate knowledge of the four main types of standard bushings--head press fit, headless press fit, fixed renewable and slip renewable.
6. Name and identify the more common types of drill jigs--channel, jig with ejector, open type jig, plate jig, and flop jig.
7. Identify milling fixtures
8. Identify and use stock jigs and fixtures in order.
9. Set and use jigs and fixtures.
10. Use cams and gears in designing and using jigs and fixtures.

JOB OPPORTUNITIES
LEVEL VIII

MECHANICAL-MACHINERY

	D.O.T. Code
Blueprinting-Machine Operator	979.782
Messenger	230.878
Blueprint Trimmer	920.887
Engineering Clerk and Drafting Clerk	249.281
Draftsman, Commercial	017.281
Apprentice Lay-Out Man	809.281
Apprentice Draftsman	007.281
Draftsman, Heating and Ventilating	017.281
City Planning Aid	199.388
Refrigeration Draftsman	017.281
Reinforced Concrete Draftsman	017.281
Delineator	970.281
Black and White Draftsman	017.281
Patient Draftsman	007.281
Mechanical Draftsman	007.281
Tool Design Draftsman	007.281
Aeronautical Draftsman	002.281
Technical Illustrator	017.281
Quality Control Technician	019.281
Engineering Assistant, Mechanical Equipment	007.181

LEVEL VI

MAPPING

Unit 1 - Metes and Bounds

The student learns to lay out subdivisions, curves using tangents, and plats using coordinates.

Unit 2 - Texas and South Louisiana measurements

The student learns about the divisions of land in Texas--headrights, surveys, etc.--and about measurements, such as varas. The student also learns how to lay out measurements from the St. Helena Meridian in Louisiana.

Unit 3 - Field notes

The student learns how to properly make lay out from field notes.

Performance Objectives and Criterion-Referenced Measures:

Upon completion of this level the student must perform within an acceptable degree, according to the instructor's standards, the following skills:

1. Lay out a plat using the coordinate method.
2. Lay out a subdivision map showing streets and curved property lines.
3. Figure acreage using the double meridian distance method.
4. Draw a plat from a Texas land description giving varas and must convert to feet.
5. Lay out a plat using the information given in a land description from the South Louisiana meridian.
6. Interpret field notes and be able to lay out a plat from them.

JOB OPPORTUNITIES
LEVEL VI

MAPPING

	D.O.T. Code
Blueprinting-Machine Operator	979.782
Messenger	230.878
Blueprint Trimmer	920.887
Engineering Clerk and Drafting Clerk	249.281
Tracer-Draftsman, Junior	017.281
Draftsman, Commercial	017.281
Apprentice Lay-Out Man	809.281
Apprentice Draftsman	007.281
Draftsman, Heating and Ventilating	017.281
City Planning Aid	119.388
Refrigeration Draftsman	017.281
Reinforced Concrete Draftsman	005.281
Topographical Draftsman	017.281
Draftsman, Oil and Gas	017.281

C U R R I C U L U M

M A P P I N G

LEVEL VI

Unit 1 Metes and Bounds
Unit 2 Texas and South Louisiana measurements
Unit 3 Field notes

RELATED SUBJECTS

Math Double Meridian distances in acreage

LEVEL VII

Unit 1 Contours
Unit 2 Profiles
Unit 3 Using profiles

RELATED SUBJECTS

Math
Use of Transit

LEVEL VIII

Unit 1 Blocking maps
Unit 2 Spotting wells
Unit 3 Meanders

LEVEL VII

MAPPING

Unit 1 - Contours

The student continues the study of contours by laying out grids and drawing contour lines working from field notes.

Unit 2 - Profiles

The student learns to draw profiles working from contour maps and field notes.

Unit 3 - Using Profiles

Working on federal aid sheets, the student learns to lay out a line across several pieces of property.

Performance Objectives and Criterion-Referenced Measures:

Upon completion of this level the student must perform within an acceptable degree, according to the instructor's standards, the following skills:

1. Lay out grids working from field notes and draw contour lines from them.
2. Draw profiles working from contour maps and from field notes.
3. Demonstrate familiarization with federal aid sheets for drawing profiles.
4. Lay out a pipe line or electric line from field notes on a federal aid sheet drawing the profile above it.

JOB OPPORTUNITIES
LEVEL VII

MAPPING

	D.O.T. Code
Blueprinting-Machine Operator	979.782
Messenger	230.878
Blueprint Trimmer	920.887
Engineering Clerk and Drafting Clerk	249.281
Tracer-Draftsman, Junior	017.281
Draftsman, Commercial	017.281
Apprentice Lay-Out Man	809.281
Apprentice Draftsman	007.281
Draftsman, Heating and Ventilating	017.281
City Planning Aid	119.388
Refrigeration Draftsman	017.281
Reinforced Concrete Draftsman	005.281
Topographical Draftsman	017.281
Draftsman, Oil and Gas	017.281
Civil Draftsman	005.281
Landscape Draftsman	019.281
Water and Sewage Draftsman	005.281
Seisomograph Draftsman	010.281

LEVEL VIII

MAPPING

Unit 1 - Blocking maps

The student learns how to block out maps from quadrant maps showing roads, rivers, lakes, townships, and sections.

Unit 2 - Spotting wells

The student learns how to spot wells using weekly information sheets. The symbols explaining the various types of wells and the many ways of using lettering to express different things are also covered.

Unit 3 - Meanders

A student learns how to lay out the meanders of rivers and indicate them on the map.

Performance Objectives and Criterion-Referenced Measures:

Upon completion of this level the student must perform within an acceptable degree, according to the instructor's standards, the following skills:

1. Using a high degree of proficiency with ink, trace a quadrant map. Must also lay out township and section lines, draw rivers, large streams and lakes, show roads and other topographical features, and show property lines and owners.
2. Spot wells on a map with a high degree of accuracy. Must also show the type of well, depth, owner of the property, owner of the mineral rights and who is drilling the well.
3. Draw the meanders of a river.

JOB OPPORTUNITIES
LEVEL VIII

MAPPING

	D.O.T. Code
Blueprinting-Machine Operator	979.782
Messenger	230.878
Blueprint Trimmer	920.887
Engineering Clerk and Drafting Clerk	249.281
Tracer-Draftsman, Junior	017.281
Draftsman, Commercial	017.281
Apprentice Lay-Out Man	809.281
Apprentice Draftsman	007.281
Draftsman, Heating and Ventilating	017.281
City Planning Aid	119.388
Refrigeration Draftsman	017.281
Reinforced Concrete Draftsman	005.281
Topographical Draftsman	017.281
Draftsman, Oil and Gas	017.281
Civil Draftsman	019.281
Landscape Draftsman	005.281
Water and Sewage Draftsman	005.281
Seismograph Draftsman	010.281
Map Draftsman	017.281
Geological Draftsman	010.281

S T R U C T U R A L S T E E L D R A F T I N G

C U R R I C U L U M

LEVEL VI

Unit 1 Connections--Bolted
Unit 2 Connections--Welded
Unit 3 Framed connections--Bolted
Unit 4 Framed connections--Welded
Unit 5 Seated connections

RELATED SUBJECTS

Strength of Materials LEVEL VI
Math Logarithms--Slopes and Rises

LEVEL VII

Unit 1 Columns
Unit 2 Braces
Unit 3 Platforms--Rectangular
Unit 4 Platforms--Circular

RELATED SUBJECTS

Strength of Materials LEVEL VII
Math Segmental Functions

LEVEL VIII

Unit 1 Working Drawings

RELATED SUBJECTS

Strength of Materials LEVEL VIII

STRUCTURAL STEEL DRAFTING

LEVEL VI

Performance Objectives and Criterion-Referenced Measures:

Upon completion of this level the student must perform within an acceptable degree, according to the instructor's standards, the following skills:

1. Design welded and bolted connections for beams.
2. Design seated connections for beams.
3. Detail beams with welded and bolted connections.
4. Detail beams with seated connections.

LEVEL VII

Performance Objectives and Criterion-Referenced Measures:

Upon completion of this level the student must perform within an acceptable degree, according to the instructor's standards, the following skills:

1. Detail columns.
2. Detail braces showing level, full length of brace and design bolt requirements.
3. Draw a complete set of working drawings of a rectangular platform.
4. Detail a circular platform using Smoley's Segmental Function.

LEVEL VIII

Performance Objective and Criterion-Referenced Measures:

Upon completion of this level the student must perform within an acceptable degree, according to the instructor's standards, the following skills:

1. Draw a complete set of working drawings from an architect's set of plans, detailing the structural steel.

JOB OPPORTUNITIES
LEVELS VI, VII, VIII

STRUCTURAL STEEL DRAFTING

	D.O.T. Code
Blueprinting-Machine Operator	979.782
Messenger	230.878
Blueprint Trimmer	920.887
Engineering Clerk and Drafting Clerk	249.281
Tracer-Draftsman, Junior	017.281
Draftsman, Commercial	017.281
Apprentice Lay-Out Man	809.281
Apprentice Draftsman	007.281
Draftsman, Heating and Ventilating	017.281
City Planning Aid	119.388
Refrigeration Draftsman	017.281
Reinforced Concrete Draftsman	005.281
Structural Draftsman	005.261

STRENGTH OF MATERIALS

CURRICULUM

LEVEL VI

Unit 1 Stretching (or contraction) of materials under load - Hooke's Law
Unit 2 Maximum allowable bearing pressures for ball, roller and sleeve bearings
Unit 3 Maximum safe loading of standard commercial wood and steel beams
Unit 4 Torsion
Unit 5 Miscellaneous: strength of welded connections; thermal expansion (and contraction) of materials subjected to changes in temperature

LEVEL VII

Unit 1 Simple beams
Unit 2 Cantilever beams
Unit 3 Deflection of beams
Unit 4 Stresses in thin-wall cylinders (pipes)

LEVEL VIII

Unit 1 Standard columns
Unit 2 Radius of gyration and moment of inertia
Unit 3 Reinforced concrete stresses
Unit 4 Laminated wood products
Unit 5 Hardness and impact tests
Unit 6 Plastics

LEVEL VI

STRENGTH OF MATERIALS

Prerequisite - Completion of Level V of Strength of Materials

Unit 1 - Stretching (or contraction) of materials under load - Hooke's Law

The student learns how to determine the change in the length of a structural member that supports a tensile load or a compressive load.

Unit 2 - Maximum allowable bearing pressures for ball, roller and sleeve bearings

The student is taught how to use handbook information to determine allowable load on bearings.

Unit 3 - Maximum safe loading of standard commercial wood and steel beams

The student is taught how to use handbook information to coordinate the span length, the spacing of beams and the expected deflection of beams to support a given load.

Unit 4 - Torsion

The student learns how to use the strength properties of steel shafting and handbook equations to compute the amount of twisting when a rotating shaft transmits a given load and also learns how to select the correct size shaft to transmit a given load.

Unit 5 - Miscellaneous: strength of welded connections; thermal expansion (and contraction) of materials subjected to changes in temperature

The student learns the application of the AWS (American Welding Society) and the AISC (American Institute of Steel Construction) specifications for strength of welded connections. The student also learns how to use the coefficient of thermal expansion of a material to determine how much a given length of the material would increase with a given increase in the temperature.

Performance Objectives:

Upon completion of this unit of related instruction the student must perform within an acceptable degree, according to the instructor's standards, the following skills:

1. Apply Hooke's Law to compute the changes in the dimensions of a simple structural member subject to a given load if the modulus of elasticity of the material is given.

2. Find and use handbook information to determine the safe load on ball, roller and sleeve bearings if the rotational speed, operating temperature, lubricating oil, strength properties of materials and other pertinent information is given.
3. Find, interpret and use standardized information on coordinating beam size, span length, and beam spacing to support a given load.
4. Compute the amount that a given shaft will twist when subjected to a given rotational force and moment arm.
5. Find and use handbook information to determine the correct diameter shaft to transmit a given horsepower load.
6. Find and use the strength properties of welding rod materials to coordinate the strength of material in the members to be welded.
7. Compute the amount of expansion (or contraction) of a given length member if the thermal coefficient of expansion is known.

Criterion-Referenced Measures:

The student must:

1. Demonstrate skill in finding and using required technical information.
2. Record the solution to a specific problem including references for less well-known design data in a neat and orderly manner.
3. Exhibit speed and accuracy in using a pocket electronic calculator, or desk calculator.
4. Prepare neat and legible sketches of each problem being solved.
5. Use commonly accepted practices in making calculations using measured data (retention of significant digits, rounding off, use of scientific notation for very large or very small numbers, etc.)

LEVEL VII

RELATED SUBJECTS

STRENGTH OF MATERIALS

Prerequisite - completion of Level V of Strength of Materials

Unit 1 - Simple Beams

The student learns how to use handbook information to find the correct size standard beam to support a given load (concentrated load or uniform load).

Unit 2 - Cantilever Beams

The student learns how to use handbook information to find the correct size standard beam to support a given load (concentrated load or uniform load).

Unit 3 - Deflection of Beams

The student learns how to use handbook information to determine the deflection of simple and cantilever beams for uniform load or concentrated load.

Unit 4 - Stresses in Thin-Wall Cylinders (Pipes)

The student is taught how to compute the tensile stress in a pipe subject to internal pressure and the external pressure on a pipe that would cause the pipe to collapse. The student is also taught how to use well-known national codes to coordinate the operating temperature and tensile stresses to determine the correct standard size pipe to safely conduct a given fluid or gas.

Performance Objectives:

Upon completion of this unit of related instruction the student must perform within an acceptable degree, according to the instructor's standards, the following skills:

1. Find the magnitude of the supports of a simple beam, if the beam has one or more concentrated loads.
2. Find the magnitude of the supports of a simple beam with a uniformly distributed load on the entire length of the beam or over any portion of the beam.
3. Use equations from handbooks to find the correct beam size to support a given load for a beam with simple supports.
4. Use equations from handbooks to find the correct beam size to support a given load on a cantilever beam.
5. Use equations from handbooks to compute the deflection of beams with simple supports or cantilever beams--with concentrated loads or uniformly distributed loads.
6. Use equations from handbooks to determine the stress in a pipe caused by the internal pressure of the fluid (or gas) in the pipe.
7. Determine the maximum allowable operating pressure for a pipe of given size, wall thickness and material.
8. Determine the external pressure that would cause a pipe of given size to collapse.
9. Use national standards correctly in determining the maximum allowable stress in pipe when the operating temperature of the pipe is several hundred degrees higher than normal ambient temperature.

Criterion-Referenced Measures:

The student must:

1. Make neat, orderly sketches of problems.
2. Document carefully the problem solutions to show all important reference sources.
3. Demonstrate skill in setting up mathematical expressions, especially the units involved, to improve the success of getting the correct numerical answer and correct units.
4. Demonstrate skill in using a pocket electronic calculator or desk-size calculator.
5. Find needed equations and codes quickly.

LEVEL VIII

RELATED SUBJECTS

STRENGTH OF MATERIALS

Unit 1 - Standard Columns

The student learns about the behavior of columns when subject to compression and the different methods of restraining the ends of a column. The student also learns the acceptable empirical equations for sizing a column for a specific load. (Bibliographic References: 33 pages 290-208; 53 pages 347-368).

Unit 2 - Radius of Gyration and Moment of Inertia

The student is taught how to compute the radius of gyration and moment of inertia of various cross-section shapes and the relation between these properties and the selection of a column to support a load. (Bibliographic References: 33 pages 96-122; 53 pages 421-445)

Unit 3 - Reinforced Concrete Stresses

The student learns how to determine stresses and deflections of reinforced concrete beams and columns and how to use the information in designing reinforced concrete beam and a reinforced concrete column. (Bibliographic References: 33 pages 220-224; 53 pages 334-346)

Unit 4 - Laminated Wood Products

The student is taught how to interpret design information provided by the manufacturers of laminated wood products.

Unit 5 - Hardness and Impact Tests

The student is introduced to the terminology and testing methods used in determining and specifying the mechanical properties of materials related to material hardness and material behavior

under impact. The student briefly learns about the relation of hardness to strength and is taught the following standard testing procedures: Brinell, Rockwell, Vickers, Shore Scleroscope, Charpy, and Izod Tests. (Bibliographic Reference No.: 42 pages 54-55 See latest MACHINERY'S HANDBOOK).

Unit 6 - Plastics

The student learns the most commonly used plastics for manufactured parts and about some of the more useful properties such as strength, melting point, machine-ability, etc. (References: Lucite, Zytel and Delrin Design Handbooks available from DuPont)

Performance Objectives:

Upon completion of this unit of related instruction the student must perform with in an acceptable degree, according to the instructor's standards, the following skills:

1. Use empirical equations to determine the cross-sectional size of a column if the length of the column is given and the method of restraining the ends if given.
2. Compute the moment of inertia and the radius of gyration of various cross-sectional shapes.
3. Determine for a reinforced concrete member the portion of the load that is supported by the concrete and the portion that is supported by the reinforcing bars.
4. Determine the size of reinforcing bars required for a reinforced concrete member.
5. Interpret correctly the design information furnished by the manufacturers of laminated wood structural members.
6. Make correct inferences from hardness and impact test data on materials.
7. Interpret correctly the properties and design information on plastics available in manufacturers' catalogs.

Criterion-Referenced Measures:

The student must:

1. Demonstrate understanding that a short, stubby column will support more load than a long, slender column of the same cross-sectional size.
2. Demonstrate understanding that the stiffness of a column depends more on the geometry of the cross-section than on the size of the cross-sectional area.
3. Demonstrate knowledge that the maximum load that a column will support depends upon the way the ends of the column are restrained.
4. Use the equations for radius of gyration and moment of inertia.

5. Use the modulus of elasticity of concrete and the modulus of elasticity of reinforcing steel to calculate the stresses and deflections of a reinforced concrete member.
6. Demonstrate understanding of the standard tests for hardness and impact strength of common materials.
7. Use design information on plastics that are commonly used for manufactured parts.
8. Use design information on laminated wood structural members.

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