

# Machine Tool Math 2

## Course Outcome Summary

### Course Information

Organization	Madison Area Technical College
Developers	Kevin Mirus
Development Date	5/25/2004
Course Number	31-804-382
Instructional Level	Two-Year Technical Diploma
Potential Hours of Instruction	33
Total Credits	1

### Description

A continuation of Machine Tool Math 1. Consists of advanced machine tool problems whose solutions involve right and oblique triangles. Compound angles and numerical control calculations are also studied.

### Types of Instruction

Instruction Type	Contact Hours	Credits
Classroom Presentation	33	1

### Textbooks

Robert D. Smith. *Mathematics for Machine Technology (4th Ed.)*. Delmar. 1999. **Edition:** 4. **Pages:** 483. **ISBN:** 0-8273-7942-0. **Source:** MATC bookstore.

Robert D. Smith. *Mathematics for Machine Technology (5th Ed.)*. Delmar. 2004. **Edition:** 5. **Unit Price:** 70.95. **Pages:** 512. **ISBN:** 1401815812. **Source:** <http://www.delmarlearning.com/>.

### Learner Supplies

A scientific calculator, like the Casio fx-300MS.. **Quantity:** 1. **Source:** MATC bookstore.

### Prerequisites

Machine Tool Math 1 (31-804-381) or its equivalent.

### Exit Learning Outcomes

#### Core Abilities

- A. Critical thinking
- B. Mathematics
- C. Science and Technology

### Competencies

#### Unit I. Tangents to Circles

- A. Explore tangent circles

**You demonstrate your competence:**

A.1. by correctly solving problems involving internally or externally tangent circles or arcs

**Your performance is successful when:**

A.1. your answer has correct magnitude stated to the correct precision

A.2. your answer is labeled with the correct unit of measurement

A.3. you draw a line or lines passing through tangent points and circle centers

A.4. you correctly label unknowns, circle radii, and the distance between the circle centers on the diagram

A.5. you write an equation that correctly relates unknowns, circle radii and the distance between the circle centers

A.6. you write any other relevant equations that correctly relate other given distances to the circle distances

A.7. you manipulate the equations in a way that leads to the correct answer correctly

**B. Solve problems involving lines tangent to a circle**

**You demonstrate your competence:**

B.1. by correctly solving problems involving lines tangent to a circle

**Your performance is successful when:**

B.1. your answer has correct magnitude stated to the correct precision

B.2. your answer is labeled with the correct unit of measurement

B.3. you draw or identify lines that are tangent to a given circle and that contain an external point

B.4. you draw radii that contain the tangent points

B.5. you draw a line containing the circle center and the external point

B.6. you label congruent tangent segments

B.7. you label congruent radii

B.8. you label the right angle(s) formed by radii and tangent segments

B.9. you label other congruent angles

B.10. you label any unknowns or given dimensions on the diagram

B.11. you write relevant equations relating relevant unknowns, distances, and/or angles

B.12. you manipulate the equations in a way that leads to the correct answer correctly

**Unit II. Complex Practical Machine Applications of Right Angle Trigonometry**

**A. Solve complex machine applications involving right triangles and tangents to circles**

**You demonstrate your competence:**

A.1. by correctly solving complex machine application problems using right triangles and tangents to circles

**Your performance is successful when:**

A.1. your answer has correct magnitude stated to the correct precision

A.2. your answer is labeled with the correct unit of measurement

A.3. you draw relevant lines containing tangent points and circle centers

A.4. you draw relevant right triangles that relate given information

A.5. you label the right triangles with correct dimensions and unknowns

A.6. you label other quantities with the correct dimensions and unknowns

A.7. you write relevant equations relating relevant unknowns, distances and/or angles

A.8. you manipulate the equations in a way that leads to the correct answer correctly

**Unit III. Geometric Constructions (This unit is optional.)**

**A. Draw fundamental geometric constructions basic to the machine trades**

**You demonstrate your competence:**

A.1. by correctly drawing fundamental geometric constructions basic to the machine trades

**Your performance is successful when:**

A.1. you construct a perpendicular bisector of a line segment

A.2. you construct a bisector of a given angle

A.3. you construct a perpendicular line to a given line segment at a given point on the line segment

A.4. you construct a perpendicular line to a given line segment at a given point not on the line segment

A.5. you construct a parallel line to a given line segment at a given distance

A.6. you construct tangents to a given circle from an outside point

A.7. you divide a given line segment into a given number of equal parts

**B. Draw typical machine shop layout problems using the methods of construction**

**You demonstrate your competence:**

B.1. by correctly drawing typical machine shop layout problems using the methods of construction

**Your performance is successful when:**

B.1. you construct certain special angles, like 30 or 67.5 degrees

B.2. you construct a tangent circle of a given radius to a given angle

B.3. you construct regular polygons of a given diameter or side length

B.4. you copy polygons using geometric construction techniques

**Unit IV. Oblique Triangles**

**A. Calculate unknown dimensions of oblique triangles**

**You demonstrate your competence:**

A.1. by correctly solving for unknown dimensions on oblique triangles

**Your performance is successful when:**

A.1. your answer has correct magnitude stated to the correct precision

A.2. your answer is labeled with the correct unit of measurement

A.3. you label sides and angles in a way that indicates you understand which sides are opposite which angles

A.4. you determine if enough information is given to solve the oblique triangle

A.5. you calculate the third angle when two angles are known

A.6. you choose between the Law of Sines and Law of Cosines, and write down the appropriate equation for your diagram

A.7. you identify the ambiguous case associated with the Law of Sines and correctly calculate both solutions when asked

A.8. you manipulate the equation in a way that leads to the correct answer

**B. Solve practical machine applications involving oblique triangles**

**You demonstrate your competence:**

B.1. by correctly solving problems involving machine applications of oblique triangles

**Your performance is successful when:**

B.1. your answer has correct magnitude stated to the correct precision

- B.2. your answer is labeled with the correct unit of measurement
- B.3. you draw relevant auxiliary lines on a given diagram to generate solvable oblique triangles
- B.4. you label sides and angles of the oblique triangles with given information in a way that indicates you understand which sides are opposite which angles
- B.5. you choose to apply the Law of Sines or Law of Cosines to each oblique triangle
- B.6. you write any other relevant equations relating relevant unknowns, distances and/or angles
- B.7. you manipulate the equation or equations in a way that leads to the correct answer

**Unit V. Reciprocal Trigonometric Functions**

**A. Calculate with the secant, cosecant, and cotangent functions**

**You demonstrate your competence:**

- A.1. by correctly solving problems involving the secant, cosecant, and cotangent functions

**Your performance is successful when:**

- A.1. your answer has correct magnitude stated to the correct precision
- A.2. your answer is labeled with the correct unit of measurement
- A.3. you show how to calculate the secant, cosecant, or cotangent of a given angle using the cosine, sine, or tangent functions, respectively
- A.4. you show how to calculate the arcsecant, arccosecant, or arccotangent of a given value using the arccosine, arcsine, or arctangent functions, respectively
- A.5. you apply formulas for calculating the secant, cosecant, cotangent, or their inverse functions

**Unit VI. Compound Angles**

**A. Calculate the true length and true angles of a body diagonal of a rectangular solid**

**You demonstrate your competence:**

- A.1. by correctly calculating the true length and true angles of a body diagonal of a dimensioned rectangular solid

**Your performance is successful when:**

- A.1. your answers have correct magnitudes stated to the correct precision
- A.2. your answers are labeled with the correct unit of measurement
- A.3. you label the length, width, and height of a rectangular solid
- A.4. you draw and label the top, front, and end views of a rectangular solid
- A.5. you draw and label the surface diagonal across the top (or bottom) face of a rectangular solid
- A.6. you calculate the length of the surface diagonal across the top (or bottom) face of a rectangular solid
- A.7. you calculate the angles made by the surface diagonal across the top (or bottom) face of a rectangular solid
- A.8. you draw and label the body diagonal of a rectangular solid
- A.9. you draw and label the right triangle containing the body diagonal of a rectangular solid
- A.10. you calculate the length of the body diagonal of a rectangular solid
- A.11. you calculate the angles of the right triangle containing the body diagonal of a rectangular solid

A.12. you apply formulas for calculating true lengths and true angles of a body diagonal

**B. Calculate angles of rotation and tilt for drilling a compound angle hole in or machining a compound angle surface on a rectangular solid**

**You demonstrate your competence:**

B.1. by correctly calculating the angles of rotation and tilt for drilling a compound angle hole in or machining a compound angle surface on a rectangular solid when given either lengths or apparent face angles

**Your performance is successful when:**

B.1. your answers have correct magnitudes stated to the correct precision

B.2. your answers are labeled with the correct unit of measurement

B.3. you draw and label a rectangular solid containing the compound angle hole as a body diagonal or containing the face to be machined off

B.4. you associate the angle of rotation for a compound angle hole with one of the angles made by the surface diagonal across the top (or bottom) face of the rectangular solid you drew

B.5. you write the correct equation to calculate the angle of rotation for a compound angle hole

B.6. you associate the angle of tilt for a compound angle hole with one of the angles of the right triangle containing the body diagonal of the rectangular solid you drew

B.7. you write the correct equation to calculate the angle of tilt for a compound angle hole

B.8. you associate the angle of rotation for a compound angle surface with the angle that is formed by the line perpendicular to the surface diagonal across the top face of the rectangular solid you drew

B.9. you write the correct equation to calculate the angle of rotation for a compound angle surface

B.10. you label the angle of tilt for a compound angle surface in the rectangular solid you drew

B.11. you write the correct equation to calculate the angle of tilt for a compound angle surface

B.12. you manipulate all equations in a way that leads to the correct answer

B.13. you apply given formulas for calculating angles of rotation and tilt when given either lengths or apparent face angles

**Unit VII. Computer Numerical Control**

**A. Identify point coordinates on a two-dimensional Cartesian coordinate system**

**You demonstrate your competence:**

A.1. by correctly stating the coordinates of a point located on a two-dimensional Cartesian coordinate system

**Your performance is successful when:**

A.1. your answer has correct magnitudes for the x and y values stated to the correct precision

A.2. your answer is labeled with the correct unit of measurement, when appropriate

A.3. your answer is stated in the correct format of (x, y)

A.4. you identify the given point as being in Quadrant I, II, III, or IV

**B. Plot points given their coordinates in a two- and three- dimensional Cartesian coordinate system**

**You demonstrate your competence:**

B.1. by plotting points given their coordinates on a two-dimensional and three dimensional Cartesian coordinate system

**Your performance is successful when:**

B.1. you draw coordinate axes for either the two dimensional or three dimensional case

B.2. you label the axes as x, y, or z

B.3. the points you plot are correctly located relative to your axes

**C. Calculate absolute and incremental positioning from engineering drawings for a point-to-point two-axis control system**

**You demonstrate your competence:**

C.1. by correctly calculating absolute and incremental positioning from engineering drawings for a point-to-point two-axis control system

**Your performance is successful when:**

C.1. your answers have correct magnitudes stated to the correct precision

C.2. your answers are labeled with the correct unit of measurement

C.3. you determine the order in which holes are to be drilled which roughly minimizes the amount of tool travel, and label the drawing with this order

C.4. you make a table to contain the absolute and/or incremental position information

C.5. you identify or determine the origin for the system and draw coordinate axes centered at this origin

C.6. you write equations relating distances given that are parallel to coordinate axes

C.7. you draw any necessary triangles to locate holes that are on a circle or specified to be at an angle to the coordinate axes

C.8. you write equations relating distances for the triangles to calculate distances parallel to coordinate axes

C.9. you write all your equations in a clear and orderly manner

C.10. you manipulate the equations in a way that leads to the correct answer

**D. Express decimal numbers as binary numbers and vice versa (This competency is optional.)**

**You demonstrate your competence:**

D.1. by correctly converting between decimal and binary numbers

**Your performance is successful when:**

D.1. your answer has correct magnitude stated to the correct precision

D.2. you break a decimal number into groups of powers of two

D.3. you write the binary equivalent of a decimal number using those groups of powers of two

D.4. you write a decimal number as a sum of powers of two

D.5. you write the decimal equivalent of a binary number by evaluating the sum of powers of two

**Unit VIII. Percentages**

**A. Distinguish between decimal fractions, common fractions, and percents**

**You demonstrate your competence:**

A.1. by correctly converting between decimal fractions, common fractions, and percent representations of parts of a whole

**Your performance is successful when:**

A.1. your answer has correct magnitude stated to the correct precision

A.2. your answer is labeled with the correct unit of measurement

- A.3. you write the conversion from a common fraction to a decimal fraction
- A.4. you write the conversion from a decimal fraction to a percent
- A.5. you write the conversion from a percent to a decimal fraction
- A.6. you write the conversion from a decimal fraction to a common fraction

**B. Determine percentage, base, or rate given two of the three quantities**

**You demonstrate your competence:**

- B.1. by correctly calculating the percentage, base, or rate given two of the three quantities

**Your performance is successful when:**

- B.1. your answer has correct magnitude stated to the correct precision
- B.2. your answer is labeled with the correct unit of measurement
- B.3. you write the equation to find the rate given the base and percentage and know when to use it
- B.4. you write the equation to find the base given the percentage and rate and know when to use it
- B.5. you write the equation to find the percentage given the rate and base and know when to use it

**C. Solve practical applications involving percents**

**You demonstrate your competence:**

- C.1. by correctly calculating the percentage, base, or rate in practical application problems

**Your performance is successful when:**

- C.1. your answer has correct magnitude stated to the correct precision
- C.2. your answer is labeled with the correct unit of measurement
- C.3. you write the equation to find the rate given the base and percentage in practical application problems
- C.4. you write the equation to find the base given the percentage and rate in practical application problems
- C.5. you write the equation to find the percentage given the rate and base in practical application problems
- C.6. you write any other equations relevant to solving practical applications relevant to percents