Idaho CTE

Precision Machining (2015): Grades 10-12

FUNDAMENTAL MACHINING SKILLS 1

1 **Comply with Safe and Efficient Work Practices** 1.1

1 Describe general shop safety rules and procedures (i.e., safety test). 1.1.1

2 Describe OSHA in workplace safety. 1.1.2

3 Comply with the required use of safety glasses, ear protection, gloves, and shoes during lab/shop activities (i.e., personal protection equipment – PPE). 1.1.3

4 Operate lab equipment according to safety guidelines. 1.1.4

5 Identify and use proper lifting procedures and proper use of support equipment (i.e. rigging, chains, straps, cables). 1.1.5

6 Utilize proper ventilation procedures for working within the lab/shop area. 1.1.6

7 Identify marked safety areas. 1.1.7

8 Identify the location and the types of fire extinguishers and other fire safety equipment; demonstrate knowledge of the procedures for using fire extinguishers and other fire safety equipment. 1.1.8

9 Identify the location and use of eye wash stations. 1.1.9

10 Identify the location of the posted evacuation routes. 1.1.10

11 Identify and wear appropriate clothing for lab/shop activities. 1.1.11

12 Secure hair and jewelry for lab/shop activities. 1.1.12

13 Demonstrate knowledge of the safety aspects of high voltage circuits. 1.1.13

14 Locate and interpret safety data sheets (SDS). 1.1.14

15 Perform housekeeping duties. 1.1.15

16 Follow verbal instructions to complete work assignments. 1.1.16

17 Follow written instructions to complete work assignments. 1.1.17

18 Demonstrate knowledge of safety by completing a written safety test. 1.1.18

2 **Maintain Immediate Work Area** 1.2

1. Demonstrate proper shop safety rules and practices. 1.2.1
2. Properly dispose of scrap metal chips, shavings, oil, and coolant. 1.2.2
3. List shop operating rules and practices. 1.2.3
4. Demonstrate procedures to clean and maintain work areas affected by operations of work and shop areas. 1.2.4
5. Demonstrate safe working practices. 1.2.5

3 **Perform Job-Related Mathematical Calculations** 1.3

1. Accurately perform job related decimal and fraction calculations. 1.3.1
2. Solve job-related problems using basic geometry. 1.3.2
3. Accurately measure a work piece and compare measurements with blueprint specifications. 1.3.3
4. Calculate the amount of material to be removed to obtain correct limits for secondary operations. 1.3.4
5. Solve job-related problems using mathematical handbooks, charts, and tables. 1.3.5
6. Convert measurements from English to metric and from metric to English units. 1.3.6
7. Calculate machine speeds and feeds using appropriate formulas. 1.3.7

4 **Read, Interpret, and Sketch Blueprints** 1.4

1. Interpret line types. 1.4.1
2. Read and interpret title blocks. 1.4.2
3. Read and interpret change orders on working and assembly prints. 1.4.3
4. Read and interpret nomenclature. 1.4.4
5. Make shop sketches. 1.4.5
6. Read and interpret blueprints, including geometric dimensioning and tolerancing. 1.4.6
7. Determine and interpret reference information used in performing machining work. 1.4.7

5 **Demonstrate Proficiency in Machine Planning** 1.5

1. Identify proper order of operations. 1.5.1
2. Identify proper machines. 1.5.2
3. Select proper work holding/fixturing. 1.5.3
4. Select proper tooling. 1.5.4

6 Perform Measuring Operations 1.6

1. Read and measure with steel rules and calipers. 1.6.1
2. Read and measure with micrometers. 1.6.2
3. Read and measure with Vernier tools. 1.6.3
4. Read and measure with dial indicators. 1.6.4
5. Measure using a surface plate. 1.6.5
6. Read and interpret surface finish. 1.6.6

7 Perform Maintenance on Machines and Tools 1.7

1. Inspect work areas to assure a safe working environment. 1.7.1
2. Lubricate equipment parts. 1.7.2
3. Clean and store hand tools, cutters, fixtures, jigs, and attachments. 1.7.3
4. Inspect and repair hand tools. 1.7.4
5. Inspect drive pulleys or belts. 1.7.5
6. Select lubricants for machining operations. 1.7.6
7. Inspect equipment for safe operational conditions. 1.7.7
8. Store grinding wheels and precision tools. 1.7.8

PERFORM BENCH WORK SKILLS 2

1 Identify Proper Hand Tools, Usage, and Applications 2.1

1. Use proper hammer types. 2.1.1
2. Use proper punches, stamps, chisels. 2.1.2
3. Use proper assembly tools. 2.1.3

2 Cut Materials by Using Hand Hacksaws 2.2

1. Explain the safety precautions/procedures for use of a hand hacksaw. 2.2.1
2. Determine teeth per inch on various hacksaw blades. 2.2.2
3. Describe the applications for saw blades with different ratios of tooth pitch. 2.2.3
4. Demonstrate the correct method of sawing materials with a hand hacksaw. 2.2.4

3 Cut Threads Using Hand Taps and Dies 2.3

1. Explain safety precautions/procedures for threading with taps and dies. 2.3.1
2. Identify and explain the use of the three taps used for threading a blind hole. 2.3.2
3. Select cutting fluids. 2.3.3
4. Describe the procedure for cutting internal and external threads with a tap or die. 2.3.4
5. Explain the correct procedure to align a tap with the hole. 2.3.5

4 Ream Holes Using Hand Reamers 2.4

1. Demonstrate the proper method of hand reaming holes using both adjustable and non-adjustable reamers. 2.4.1
2. Explain the types of lubricants and their applications to reaming. 2.4.2
3. Explain the correct drill sizes as they relate to the various sizes of reamers. 2.4.3

5 Remove Damaged Screw and Other Hardware 2.5

1. Explain the safety precautions/procedures for using easy outs and tap extractors. 2.5.1
2. Explain the purpose of easy outs and tap extractors. 2.5.2
3. Determine the correct drill sizes used with various easy outs. 2.5.3
4. Determine the correct tap extractor for various taps. 2.5.4
5. Remove damaged screws. 2.5.5

6 Set Up and Use Arbor Press Broaches 2.6

1. Determine proper broach size. 2.6.1
2. Explain why broaches have to shimmed. 2.6.2
3. Explain why lubricant is required. 2.6.3
4. Cut splines and keyways utilizing broaches, bushings, shims and arbor presses. 2.6.4

7 Deburr Work Pieces 2.7

1. Select proper deburring tool. 2.7.1
2. Demonstrate how to properly hold deburring tool and machinist scrapers. 2.7.2
3. Demonstrate how to sharpen machinist scrapers. 2.7.3
4. Deburr work pieces to required tolerances. 2.7.4

SET UP AND OPERATE POWER SAWS 3

1 Comply with Safe and Efficient Work Practices 3.1

1. Explain what could be the possible injuries resulting from improper safety precautions. 3.1.1
2. Identify hazardous components of saws. 3.1.2
3. Demonstrate knowledge of safety by completing a written safety test. 3.1.3

2 **Remove and Replace Saw Blades** 3.2

1. Explain why the teeth of the blade must point in the correct direction for each type of machine. 3.2.1
2. Explain why the blades of reciprocating saws must be elevated a certain distance above the work piece before starting the machine. 3.2.2
3. Describe the procedures for replacing saw blades. 3.2.3
4. Replace blades in hand and reciprocating saws. 3.2.4

3 **Select Appropriate Blades to Perform Given Sawing Operations** 3.3

1. Explain how the width of the blade and radius desired in contour cutting have a direct effect on each other. 3.3.1
2. Explain how the number of teeth per inch and the thickness of the work piece affect each other. 3.3.2
3. Describe a bi-metal saw blade for a reciprocating type machine. 3.3.3

4 **Select and Set Speeds for Sawing Operations** 3.4

1. Select the correct cutting speed for specific material. 3.4.1
2. Explain how coolant can affect speeds and feeds. 3.4.2

5 **Measure and Cut Off Materials using Power Saws** 3.5

1. Explain the safety precautions/procedures before operating power saws. 3.5.1
2. Determine the proper amount of material that must be left on a work piece for machining. 3.5.2
3. Describe procedure and cut material to layout or scribed line. 3.5.3

6 **Cut and Weld Band Saw Blades** 3.6

1. Perform proper saw blade welding operation. 3.6.1
2. Describe the procedures for measuring and cutting saw blades to length. 3.6.2
3. Explain the reasons for annealing the saw blade after the welding operation. 3.6.3
4. Describe the procedures for grinding a saw blade before installation. 3.6.4
5. Describe the procedure for selecting the proper guides. 3.6.5

7 **Set Up and Operate Saws for Angular Cutting** 3.7

1. Explain the reasons for cutting as close to the layout lines as possible. 3.7.1
2. Explain the reason for cutting angles on a band saw as opposed to using other machines. 3.7.2
3. Set up a saw for angular cutting. 3.7.3
4. Perform an angular cut on a work piece. 3.7.4

SET UP AND OPERATE PEDESTAL GRINDERS 4

1. **Comply with Safe and Efficient Work Practices** 4.1
   1. Demonstrate the operation of pedestal grinders' safety devices. 4.1.1
   2. Demonstrate knowledge of safety by completing a written safety test. 4.1.2
2. **Identify Parts of the Pedestal Grinder and Know Their Function** 4.2
   1. Identify types of pedestal grinders. 4.2.1
   2. Identify major parts and their functions. 4.2.2
3. **Select Appropriate Grinding Types** 4.3
   1. Understanding and selecting proper wheel type. 4.3.1
4. **Mount Grinding Wheels** 4.4
   1. Explain how to determine if a wheel is cracked before mounting. 4.4.1
   2. Explain the importance of cleanliness when mounting wheel. 4.4.2
   3. Explain the importance of the blotters on the wheel. 4.4.3
   4. Explain the reasons for the manufacturer printing the operating speed on grinding wheels. 4.4.4
   5. Explain the safety precautions in regard to the diameter of the flanges in relationship to the diameter of the wheel. 4.4.5
   6. Explain procedure to determine how tight the wheel flanges should be. 4.4.6
   7. Dress wheel and adjust wheel guard and tool rest. 4.4.7
5. **Set Up Tool Rests** 4.5
   1. Explain the purpose of the tool rest. 4.5.1
   2. Demonstrate the proper procedure required for adjusting tool rest. 4.5.2
6. **Dress Grinding Wheel** 4.6
   1. Identify the different types of wheel dressers. 4.6.1
   2. Demonstrate the procedure for dressing and truing a grinding wheel. 4.6.2

HAND-SHARPEN CUTTING TOOLS 5

1. **Comply with Safe and Efficient Work Practices** 5.1
   1. Demonstrate knowledge of safety by completing a written safety test. 5.1.1
2. **Grind High Speed Tool Bits** 5.2
   1. Understand selection of the proper grinding wheel. 5.2.1
   2. Identify and properly grind the appropriate clearances, i.e. rake, relief, and radius. 5.2.2

3 Grind Brazed Carbide Tool Bits 5.3

1. Understand selection of the proper grinding wheel. 5.3.1
2. Identify and properly grind the appropriate clearances, i.e. rake, relief, and radius. 5.3.2

4 Grind Drill Bits 5.4

1. Identify the parts of the drill bit. 5.4.1
2. Describe the amount of lip clearance a drill must have to perform correctly. 5.4.2
3. Explain why a drill bit must have the same lip angle and length. 5.4.3
4. Discuss why different drill point angles are ground for different materials. 5.4.4
5. Describe and demonstrate the procedures for hand sharpening a drill bit. 5.4.5
6. Describe the procedure for correcting a thick web on a drill bit. 5.4.6

SET UP AND OPERATE LATHES 6

1 Comply with Safe and Efficient Work Practices 6.1

1. Explain the need for safety glasses. 6.1.1
2. Explain the hazards of chip handling. 6.1.2
3. Explain the set up hazards. 6.1.3
4. Explain the chuck removal and installation hazards. 6.1.4
5. Explain the hazards of work piece burrs. 6.1.5
6. Explain the proper housekeeping and tool hazards. 6.1.6
7. Demonstrate the knowledge of safety by completing a written safety test. 6.1.7

2 Identify the Parts of the Lathe 6.2

1. Explain the major parts of the lathe and their functions. 6.2.1

3 Set up an Engine Lathe 6.3

1. Explain the relevant safety precautions/procedures for mounting/removing chucks on lathes. 6.3.1
2. Explain how to operate a lathe. 6.3.2
3. Demonstrate the correct selection, installation, and use of work holding devices. 6.3.3

4 Secure Tools, Tool Holders, and Fixtures or Attachments 6.4

1. Describe the proper selection of tool holding devices. 6.4.1
2. Describe the use of tool holders, fixtures and attachments. 6.4.2
3. Describe the mounting of tool bits. 6.4.

5 **Select and Set Feeds and Speeds** 6.5

1. Locate, speed and feed chart on each machine. 6.5.1
2. List spindle speed formula and calculate appropriate RPM. 6.5.2
3. Demonstrate correct speed and feed application. 6.5.3

6 **Set Up Lathes and Face Work Pieces Held in Chucks** 6.6

1. Describe the uses of carbide, high speed, and cutting tools as applied to facing operations. 6.6.1
2. Calculate cutting speeds and feeds for facing operations. 6.6.2
3. Describe the procedures for facing. 6.6.3
4. Select the correct cutting fluids for facing. 6.6.4
5. Face a work piece to specifications. 6.6.5

7 **Rough-Cut and Finish-Cut with Lathes** 6.7

1. Calculate the correct speeds and feeds for the appropriate operation. 6.7.1
2. Explain tool position and tool geometry (angles). 6.7.2
3. Define and make trial cuts. 6.7.3
4. Using appropriate measuring tools, measure work piece. 6.7.4
5. Perform required rough and finish cuts to specifications. 6.7.5

8 **Perform Lathe Deburring Operations** 6.8

1. Identify and demonstrate proper selection and use of deburring tools. 6.8.1
2. Calculate the correct speeds for deburring operation. 6.8.2
3. Explain grit size of abrasive clothes. 6.8.3
4. File, polish and deburr a work piece. 6.8.4
5. Explain the use of appropriate inspection gages. 6.8.5

9 **Align Lathe Centers Using Accurate Methods** 6.9

1. Describe the geometry of alignment of centers. 6.9.1
2. Align centers using the point to point method. 6.9.2
3. Align centers using a precision ground centered shaft. 6.9.3
4. Align centers using the cut and measuring method. 6.9.4

10 **Drill with Lathes** 6.10

1. Describe the procedures for drilling on a lathe. 6.10.1
2. Calculate speeds for drilling operations. 6.10.2
3. Select the correct cutting fluids for drilling operations. 6.10.3
4. Drill a hole in a work piece. 6.10.4

11 Countersink Holes with Lathes 6.11

1. Describe the procedures for countersinking holes on a lathe. 6.11.1
2. Calculate speeds for countersinking operations. 6.11.2
3. Select the correct cutting fluid for countersinking operations. 6.11.3
4. Countersink a hole in a work piece. 6.11.4
5. Explain the use of appropriate inspection gages. 6.11.5

12 Ream Holes with Lathes 6.12

1. Describe the procedures for reaming a hole on a lathe. 6.12.1
2. Calculate speeds for reaming a hole. 6.12.2
3. Select the correct cutting fluid for reaming operations. 6.12.3
4. Ream a hole in a work piece. 6.12.4

13 Tap Threads with Lathes 6.13

1. Select the proper tap for the operation. 6.13.1
2. Determine tap drill size using the charts and formulas. 6.13.2
3. Describe the procedures for tapping threads with a lathe. 6.13.3
4. Calculate speeds for tapping operations. 6.13.4
5. Select the correct cutting fluid for tapping operations. 6.13.5
6. Tap a hole in a work piece. 6.13.6
7. Explain the use of appropriate inspection gages. 6.13.7

14 Counter Bore Holes with Lathes 6.14

1. Describe the procedures for counter boring on a lathe. 6.14.1
2. Calculate speeds for counter boring operations. 6.14.2
3. Select the correct cutting fluid for counter boring operations. 6.14.3
4. Counter bore a hole in a work piece. 6.14.4
5. Explain the use of appropriate inspection gages. 6.14.5

15 Bore Holes with Lathes 6.15

1. Describe the procedures for boring holes. 6.15.1
2. Select the correct tool and tool holder for boring holes. 6.15.2
3. Calculate speeds and feeds for boring operations on lathes. 6.15.3
4. Select the correct cutting fluids for boring. 6.15.4
5. Bore a hole in a work piece. 6.15.5

16 Knurl Parts with Lathes 6.16

1. Describe the procedures for knurling. 6.16.1
2. Select the correct tool and tool holder for knurling. 6.16.2
3. Calculate speeds and feeds for knurling. 6.16.3
4. Select the correct cutting fluids for knurling. 6.16.4
5. Knurl a work piece. 6.16.5
6. Explain the use of inspection gages. 6.16.6

17 Cut External Threads with Lathes 6.17

1. Describe the procedures for cutting external threads. 6.17.1
2. Explain the formulas used in the three wire system for measuring external threads. 6.17.2
3. Select appropriate speeds for cutting external threads. 6.17.3
4. Select the correct cutting fluid for threading operations. 6.17.4
5. Calculate thread depth. 6.17.5
6. Calculate total in feed of compound. 6.17.6
7. Determine depth per pass. 6.17.7
8. Determine compound off-set angle (right or left hand threads). 6.17.8
9. Cut external threads on a work piece. 6.17.9
10. Explain the use of inspection gages. 6.17.10

18 Chase Threads with Lathes 6.18

1. Describe the procedures for chasing threads. 6.18.1
2. Select appropriate speeds for chasing external threads. 6.18.2
3. Select the correct cutting fluid for threading operations. 6.18.3
4. Determine depth per pass. 6.18.4
5. Determine compound off-set angle (right or left hand threads). 6.18.5
6. Chase threads on a work piece. 6.18.6

19 Cut Internal Threads with Lathes 6.19

1. Describe the procedures for cutting internal threads. 6.19.1
2. Explain the use of appropriate inspection gages. 6.19.2
3. Select the appropriate speeds for cutting internal threads. 6.19.3
4. Select the correct cutting fluid for threading operations. 6.19.4
5. Calculate thread depth. 6.19.5
6. Calculate total in feed of compound. 6.19.6
7. Determine depth per pass. 6.19.7
8. Determine compound off-set angle (right or left hand threads). 6.19.8
9. Cut external threads on a work piece. 6.19.9

20 Set Up and Perform Taper Turning with Taper Attachments 6.20

1. Explain the use of taper attachments. 6.20.1
2. Describe the procedures for cutting external tapers. 6.20.2
3. Calculate speeds and feeds for external tapering operations. 6.20.3
4. Explain how to inspect a taper. 6.20.4
5. Select the correct cutting fluids for external tapering operations. 6.20.5
6. Turn an external taper on a work piece. 6.20.6
7. Explain the use of appropriate inspection gages. 6.20.7

21 Set Up and Perform Taper Turning with Compound Rest 6.21

1. Explain the procedure for cutting a taper utilizing the compound rest. 6.21.1
2. Calculate speed for taper turning. 6.21.2
3. Explain how to inspect a taper. 6.21.3
4. Select the correct cutting fluids for taper turning operations. 6.21.4
5. Turn a taper on a work piece. 6.21.5
6. Explain the use of appropriate inspection gages. 6.21.6

22 Perform Contour, Angular, or Radius Cuts with Lathes 6.22

1. Describe the procedures for angular concave or contour cuts with lathes. 6.22.1
2. Explain the proper use of radius gages. 6.22.2
3. Calculate speeds for free hand forming operations. 6.22.3
4. Describe the procedures for free hand forming concave and convex radii. 6.22.4
5. Select the correct cutting fluids. 6.22.5
6. Cut contour, concave and angular surfaces on a work piece. 6.22.6
7. Explain the use of appropriate inspection gages. 6.22.7

23 Set Up and Use Follower and Steady-Rests 6.23

1. Describe the use of follower rests and steady-rests. 6.23.1
2. Install steady rest or follower rest and adjust to part. 6.23.2
3. Turn work to size with proper follow and steady rest setup. 6.23.3
4. Face and center drill part using steady-rest. 6.23.4
5. Explain the use of appropriate inspection gages. 6.23.5

24 Set Up Face Plates and Lathe Dogs 6.24

1. Describe the procedure to install work using a face plate and lathe dog. 6.24.1
2. Describe the use of the face plate and the importance of counter-balancing the work piece. 6.24.2
3. Describe the procedure for clamping and aligning part to face plate. 6.24.3

SET UP AND OPERATE MILLING MACHINES 7

1 Comply with Safe and Efficient Work Practices 7.1

1. Describe general shop safety rules and procedures (i.e. safety test). 7.1.1
2. Describe OSHA in workplace safety. 7.1.2
3. Comply with the required use of safety glasses, ear protection, gloves, and shoes during lab/shop activities (i.e., personal protection equipment (PPE) 7.1.3
4. Operate lab equipment according to safety guidelines. 7.1.4
5. Identify and use proper lifting procedures and proper use of support equipment (.e.e rigging, chains, straps, cables). 7.1.5
6. Utilize proper ventilation procedures for working within the lab/shop area. 7.1.6
7. Identify marked safety areas. 7.1.7
8. Identify the location and the types of fire extinguishers and other fire safety equipment; demonstrate knowledge of the procedures for using fire extinguishers and other fire safety equipment. 7.1.8
9. Identify the location and use of eye wash stations. 7.1.9
10. Identify the location of the posted evacuation routes. 7.1.10
11. Identify and wear appropriate clothing for lab/shop activities. 7.1.11
12. Secure hair and jewelry for lab/shop activities. 7.1.12
13. Demonstrate knowledge of the safety aspects of high voltage circuits. 7.1.13
14. Locate and interpret safety data sheets (SDS). 7.1.14
15. Perform housekeeping duties. 7.1.15
16. Follow verbal instructions to complete work assignments. 7.1.16
17. Follow written instructions to complete work assignments. 7.1.17
18. Demonstrate knowledge of safety by completing a written safety test. 7.1.18

2 Identify the Parts of the Horizontal and Vertical Milling Machines and Know Their Functions 7.2

1. Describe the function of major parts. 7.2.1

3 Lubricate Milling Machines 7.3

1. Explain the safety precautions/procedures for cleaning, lubricating and inspecting the milling machine. 7.3.1
2. Explain the reasons for performing routine cleaning, inspection, and lubrication of milling machines. 7.3.2
3. Determine the proper lubricants to be used for milling machines. 7.3.3
4. Explain the meaning of the terms (a) climb; (b) conventional milling. 7.3.4
5. Describe the procedures for cleaning, lubricating and inspecting the milling machine. 7.3.5
6. Lubricate a milling machine. 7.3.6

4 True Up the Head and Align Milling Machine Fixtures 7.4

1. Explain the safety precautions/procedures in alignment of heads. 7.4.1
2. Explain the operation of a swivel head on a mill. 7.4.2
3. Explain the use of dial indicator for aligning swivel heads. 7.4.3
4. Align a vise on a milling table. 7.4.4
5. Align a head of a milling machine. 7.4.5

5 Select and Set Feeds and Speeds for Milling Work 7.5

1. List the correct cutting speed and feed for various materials. 7.5.1
2. Set correct feeds and speeds on a milling machine for various materials. 7.5.2

6 Square Up Work Pieces with a Table Vise 7.6

1. Calculate the correct speeds and feed for various cutters. 7.6.1
2. Describe the procedures for setting-up and machining a work piece parallel and square. 7.6.2
3. Identify the correct cutting fluids for milling. 7.6.

7 Perform End Milling 7.7

1. Calculate proper speeds, feeds and depth of cut with end milling. 7.7.1
2. Describe the procedures for setting up and end milling a flat surface. 7.7.2
3. Identify the correct cutting fluids for milling. 7.7.3
4. End mill a flat surface. 7.7.

8 Perform Fly-Cutting Operations 7.8

1. Define surface roughness, waviness, lay and identify their symbols. 7.8.1
2. Explain the purpose of fly-cutters. 7.8.2
3. Calculate speeds, feeds, and determine depth of cut for fly-cutting surfaces. 7.8.3
4. Describe the procedures for fly-cutting surfaces. 7.8.4
5. Fly-cut a work piece surface to required tolerances. 7.8.5

9 Drill Holes with a Milling Machine 7.9

1. Describe the procedures for using milling machine dials for accurate table positioning. 7.9.1
2. Calculate the amount of table movement for each position. 7.9.2
3. Describe the procedures for compensating for backlash out the lead screws. 7.9.3
4. Calculate the correct speed and feed. 7.9.4
5. Drill holes in a work piece to specified tolerances using a milling machine. 7.9.5

10 Perform Reaming Operations 7.10

1. Explain the uses of centerdrills, drills, and reamers. 7.10.1
2. Calculate proper speeds and feeds for centerdrilling, drilling, and reaming operations. 7.10.2
3. Describe the procedures for centerdrilling, drilling, and reaming on a milling machine. 7.10.3
4. Identify the correct cutting fluids for centerdrilling, drilling and reaming. 7.10.4
5. Determine the proper drill size for reaming. 7.10.5
6. Ream a hole in a work piece holding required tolerances. 7.10.6

11 Cut External Keyways 7.11

1. Calculating proper speeds, feeds, and depth of cut when milling keyseats. 7.11.1
2. Describe the procedures for setting up and milling keyseats. 7.11.2
3. Identify the correct cutting fluids for milling keyseats. 7.11.3
4. Determine keyway depth. 7.11.4
5. End mill a keyseat in a work piece holding required tolerances. 7.11.5

12 Bore Holes with Milling Machines 7.12

1. Explain the procedures for accurately adjusting a boring head. 7.12.1
2. Calculate speeds and feeds for boring operations. 7.12.2
3. Describe the procedures for setting up and completing boring operations. 7.12.3
4. Identify the correct cutting fluids for boring and counterboring. 7.12.4
5. Bore a hole in a work piece using a boring head on a milling machine to required tolerances. 7.12.5

13 Perform Form Milling 7.13

1. Define the terms concave and convex as they pertain to milling cutters. 7.13.1
2. Calculate speeds, feeds, and depth of cut for milling cutter. 7.13.2
3. Describe the procedures for form milling. 7.13.3
4. Identify the correct cutting fluids. 7.13.4
5. Form mill a work piece to required tolerances. 7.13.

14 Perform Indexing Operations Using a Dividing Head 7.14

1. Explain the calculations for the indexing head when performing differential indexing. 7.14.1
2. Explain the proper technique for assembling gears in gear train. 7.14.2
3. Define simple gearing and compound gearing. 7.14.3

15 Set Up and Operate Rotary Tables 7.15

1. Describe set up and clamping procedures for a rotary table. 7.15.1
2. List the applications for a rotary table. 7.15.2
3. Explain the procedures for avoiding backlash of rotary table and milling machine screws. 7.15.3
4. Calculate the correct speeds for machining outside radius. 7.15.4
5. Describe the procedure for milling outside radius using a rotary table. 7.15.5
6. Identify the correct cutting fluids. 7.15.6
7. Describe the procedures for centering spindle with rotary table. 7.15.7

16 Perform Cutting-Off Operation 7.16

1. Explain how to calculate depths, speeds and feeds for slitting saws. 7.16.1
2. Explain how to set up work pieces with kickers to cut precision lengths. 7.16.2
3. Cut work pieces to precision lengths. 7.16.3
4. Slot various shapes of work pieces. 7.16.4

17 Set Up and Perform Slab Mill Operations 7.17

1. Explain the importance of maintaining a clean milling machine. 7.17.1
2. Describe procedures for mounting cutter and arbor in the milling machine. 7.17.2
3. Explain why the cutter should always be mounted on the arbor as close to the column of the milling machine as possible. 7.17.3
4. Describe the procedures for slab milling operations. 7.17.4
5. Identify the correct cutting fluid. 7.17.5
6. Explain the purpose of the applications for using climb milling and conventional milling. 7.17.6

18 Use an Edge Finder and Wiggler 7.18

1. Explain the correct care and use of an edge finder or wiggler. 7.18.1
2. Describe the procedures for touching off with an edge finder and a wiggler. 7.18.2
3. Locate the center of a work piece after locating it with a wiggler or edge finder. 7.18.3

19 Position a Table 7.19

1. Describe the procedures for accurate table positioning. 7.19.1
2. Calculate the amount of table movement for each position. 7.19.2
3. Describe the procedures for keeping backlash out of lead screws. 7.19.3
4. Calculate the correct cutting speed and feed. 7.19.4
5. Describe the procedures for drilling equally spaced holes. 7.19.5
6. Drill equally spaced holes in a work piece. 7.19.6

20 Set Up and Use a Sine Bar 7.20

1. Describe the care and use of parallels. 7.20.1
2. Describe the procedures for seating a part in a milling vise. 7.20.2
3. Set up and seat a work piece in a vise. 7.20.

SET UP AND OPERATE DRILL PRESSES 8

1 Comply with Safe and Efficient Work Practices 8.1

1. Demonstrate knowledge of safety by completing a written safety test. 8.1.1

2 **Explain the Different Types of Drill Presses** 8.2

1 Identify the parts of the drill press. 8.2.1

2 Demonstrate the procedure for adjusting the table height. 8.2.2

3 Calculate the RPM and feed for various size drills and materials. 8.2.3

4 Demonstrate the selection of the correct RPM settings and feed settings. 8.2.4

5 Explain the use of the drill chuck and Morse tapered spindle. 8.2.5

6 Explain the use of drill press work holding devices. 8.2.6

3 **Center Drill, Drill, and Ream a Hole in a Work Piece** 8.3

1 Describe the procedures for center drilling and drilling holes. 8.3.1

2 Describe the procedures for reaming holes. 8.3.2

3 Select the proper cutting fluids for drill press. 8.3.3

4 Center drill, drill, and ream a hole in a work piece to required tolerance. 8.3.4

4 **Counter Bore, Spot Face, and Countersink a Hole in a Work Piece** 8.4

1 Explain the purpose of counter boring, spot facing, and countersinking a hole. 8.4.1

2 Describe the procedures for counter boring, counter sinking and spot facing holes. 8.4.2

3 Select the correct cutting fluids for counter boring, counter sinking, and spot facing. 8.4.3

4 Counter bore, spot face, and counter sink a hole in a work piece to required tolerance. 8.4.4

5 **Hand Tap a Hole in Work Piece** 8.5

1 Describe the procedures for hand tapping a hole with a drill press to assure perpendicularity. 8.5.1

6 **Power Tap a Hole in Work Piece** 8.6

1 Distinguish between power and hand taps. 8.6.1

2 Describe the procedures for machine tapping holes. 8.6.2

3 Select the proper accessory to perform a power tapping procedure 8.6.3

4 Select the correct cutting fluids for power tapping 8.6.4

5 Power tap a hole in a work piece to required tolerance. 8.6.5

7 **Use Appropriate Inspection Gages** 8.7

1 Explain the use of appropriate inspection gages. 8.7.1