

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/fixtures. 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
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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
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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
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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
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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
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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
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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
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3 Select Appropriate Grinding Types 4.3

- 1 Understanding and selecting proper wheel type. 4.3.1
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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
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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
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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
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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
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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
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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
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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
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2 Identify the Parts of the Lathe 6.2

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