

Apprenticeship and Industry Training

Machinist

Curriculum Guide

015 (2022)



Apprenticeship
and Industry
Training

ALBERTA ADVANCED EDUCATION

Machinist : apprenticeship education program curriculum guide

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**Machinist
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CURRICULUM GUIDE

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Apprenticeship

Apprenticeship is post-secondary education with a difference. Apprenticeship begins with finding a sponsor. Sponsors guide apprentices, and support on-the-job learning through provision of mentorship. Approximately 80 per cent of an apprentice's time is spent on the job under the supervision of a certified journeyman or qualified tradesperson. The other 20 per cent involves technical training provided at, or through, a post-secondary institution (PSI) – usually a college or technical institute.

To receive their post-secondary credential, apprentices must learn theory and skills, and they must pass examinations. Criteria for the program—including the content and delivery of technical training—are developed and updated by the Registrar.

The graduate of the Machinist apprenticeship education program is an individual who will be able to:

- understand the principles of sound and safe trade practice
- interpret drawings, plans, and be able to layout and develop projects according to specifications
- use the tools of the trade in a safe and proper manner
- relate to the work of other tradespeople employed in the industry either on construction or in maintenance
- perform assigned tasks in accordance with quality and production standards required in industry

Apprenticeship and Industry Training System

Alberta's apprenticeship education programs are supported by industry stakeholders that ensures a highly skilled, internationally competitive workforce in the province. The Registrar establishes the educational standards and provides direction to the system supported by industry and the PSI's. The Ministry of Advanced Education provides the legislative framework and administrative support for the apprenticeship and industry training system.

Special thanks are offered to the following industry members who contributed to the development of the standard:

Mr. B. Wermann Edmonton
Mr. G. Callies Gwynne
Mr. M. Desjardins Calgary
Mr. D. Short Edmonton
Mr. J. Irving South
Mr. M. Gamache Edmonton
Mr. N. Forbes Edmonton
Mr. R. Roes Peace River
Mr. K. McGrath Red Deer

Alberta Government

Alberta Advanced Education works with industry, sponsor and employee organizations and technical training providers to:

- facilitate industry's development and maintenance of training and certification standards
- provide registration and counselling services to apprentices and sponsors
- coordinate technical training in collaboration with training providers
- certify apprentices and others who meet industry standards

Apprentice Safety

Safe working procedures and conditions, incident/injury prevention, and the preservation of health are of primary importance in apprenticeship education programs in Alberta. These responsibilities are shared and require the joint efforts of government, sponsors, employees, apprentices and the public. Therefore, it is imperative that all parties are aware of circumstances that may lead to injury or harm.

Safe learning experiences and healthy environments can be created by controlling the variables and behaviours that may contribute to or cause an incident or injury. By practicing a safe and healthy attitude, everyone can enjoy the benefit of an incident and injury free environment.

Occupational Health and Safety

Persons engaged in, or supporting an individual in an experiential learning environment are often exposed to more worksite hazards than in other forms of traditional post-secondary education and therefore should be familiar with and apply the Occupational Health and Safety Act, Regulations and Code when dealing with personal safety and the special safety rules that apply to all daily tasks.

Occupational Health and Safety-OHS (a division of Alberta Labour and Immigration) conducts periodic inspections of workplaces to ensure that safety regulations for industry are being observed.

Additional information is available at www.alberta.ca/occupational-health-safety.aspx

Technical Training

Apprenticeship technical training is delivered by the PSI's throughout Alberta. The PSI's are committed to delivering the technical training component of Alberta apprenticeship education programs in a safe, efficient and effective manner. All PSI's place a strong emphasis on safety that complements safe workplace practices towards the development of a culture of safety for all professions.

The PSI's work with industry and Alberta Advanced Education to enhance access and responsiveness to industry needs through the delivery of the technical training component of apprenticeship programs across the province. They develop curriculum from the curriculum guides established by the Registrar in consultation with the PSI's and industry and provide the technical training to apprentices.

The following PSI's deliver Machinist trade apprenticeship technical training:

Northern Alberta Institute of Technology Southern Alberta Institute of Technology

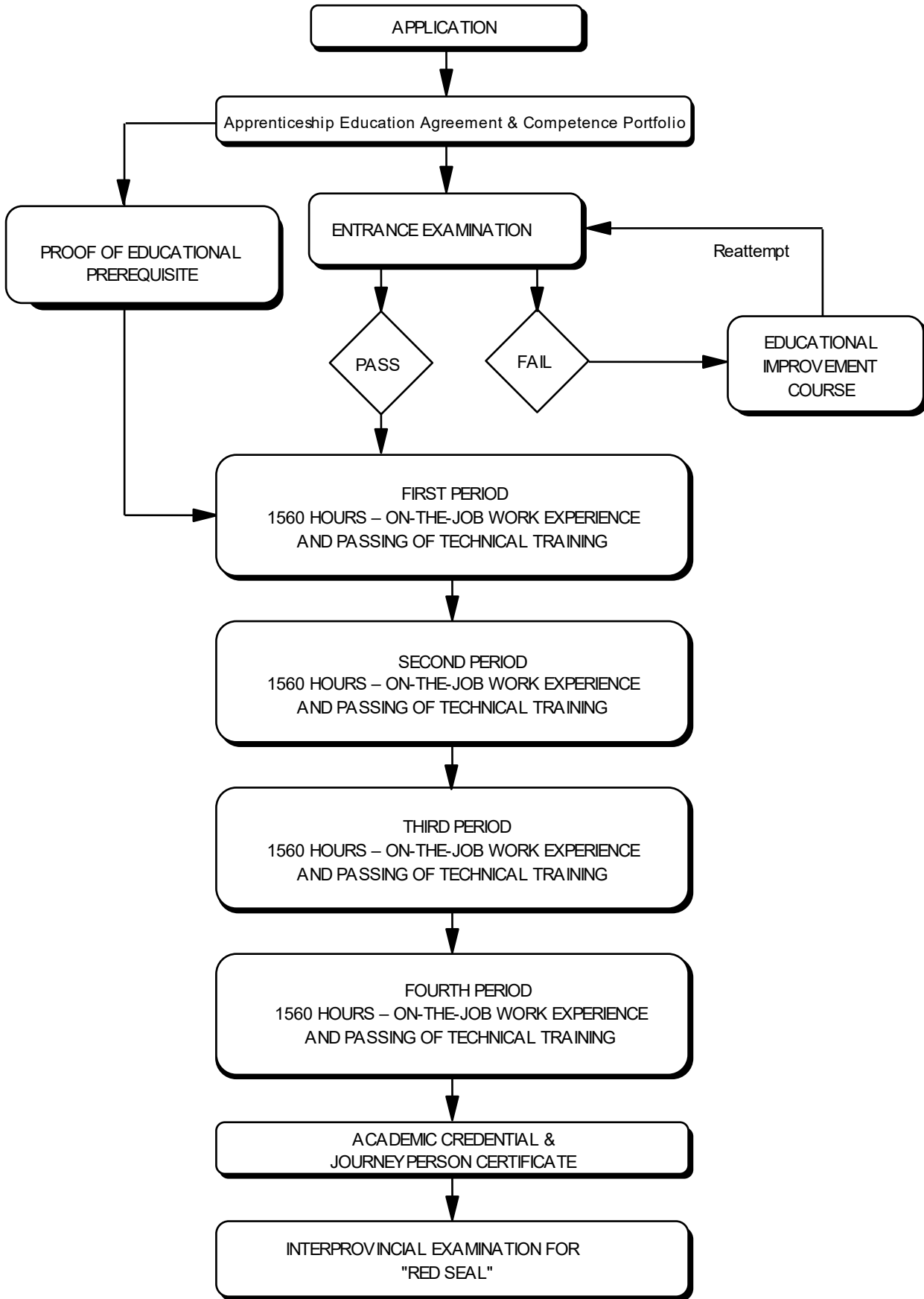
Procedures for Recommending Revisions to the Curriculum Guide

Any concerned individual or group in the province of Alberta may make recommendations for change by writing to:

Registrar of Apprenticeship Education Programs
c/o Apprenticeship Delivery and Industry Support Services
Apprenticeship Delivery and Industry Support
Advanced Education
19th floor, Commerce Place
10155 102 Street NW
Edmonton AB T5J 4L5

It is requested that recommendations for change refer to specific areas and state references used.

Apprenticeship Route toward Academic Credential



**Machinist Training Profile
FIRST PERIOD
(8 Weeks 30 Hours per Week – Total of 240 Hours)**

SECTION ONE

SAFETY AND MEASUREMENT
15%



A	B	C
Safety Legislation, Regulation & Industry Policy in the Trades 6%	Climbing, Lifting, Rigging and Hoisting 6%	Hazardous Materials & Fire Protection 5%
D	E	F
Oxy-fuel Equipment Safety 11%	Layout Tools and Procedures 8%	Hand-Held Cutting Tools 17%
G	H	I
Measurement Tools 11%	Angular Measuring Tools 8%	Screw Thread Terminology 14%
J	K	
Screw Thread Measuring and Gauging 8%	Inspection Gauges 6%	

SECTION TWO

MACHINE TOOLS
58%



A	B	C
Hand Grinding Machines 6%	Power Saws 2%	Speeds, Feeds and Cutting Tools 6%
D	E	F
Drilling Machines 11%	Lathes 4%	Lathe Attachments and Accessories 7%
G	H	I
Lathe Operations 42%	Machine Lubrication and Cutting Fluids 2%	Introduction & Application of CNC Turning Machines 1%
J	K	L
Machine Coordinate Systems for CNC Turning Machines 1%	Parts & Workholding Accessories for CNC Turning Machines 1%	Set-up & Operation for CNC Turning Machines 17%

SECTION THREE

TRADE MATH
14%



A	B	C
Working with Numbers 13%	Fractions, Decimals & Percentages 13%	Algebra 19%
D	E	F
Measurement and Conversions 12%	Ratio and Proportion 9%	Taper Systems 9%
G		
Introduction to Triangles and Trigonometry 25%		

SECTION FOUR

PRINT READING
13%



A

Introduction to Print Reading
25%

B

Dimensioning Methods
6%

C

Sections
6%

D

Isometric Drawings
6%

E

Surface Texture (Finish) -
Turning
10%

F

Introduction to Geometric
Dimensioning and
Tolerancing
10%

G

Introduction to Limits and Fits
6%

H

Introduction to Computer Aided
Design (CAD) and Computer
Aided Manufacturing (CAM)
25%

I

Fasteners and Locking
Devices
6%

SECOND PERIOD
(8 Weeks 30 Hours per Week – Total of 240 Hours)

SECTION ONE

METALLURGY AND HEAT TREATMENT
 8%



A

Ferrous Metals
 33%

B

Non-Ferrous Metals
 33%

C

Metal Specifications and Testing
 34%

SECTION TWO

TOOLING
 7%



A

Tool and Workholding Devices
 13%

B

Milling Cutters
 25%

C

Cutting Tool Materials
 25%

D

Inserts and Tool Holders
 37%

SECTION THREE

MACHINE TOOLS
 64%



A

Milling Machines
 3%

B

Milling Operations
 38%

C

Dividing Head and Indexing
 3%

D

Threading
 13%

E

Program and Machine Coordinate Systems for CNC Machining Centers
 1%

F

Parts for CNC Machining Centers
 3%

G

Programming Concepts and Codes for CNC Machining Centers
 4%

H

Set-up and Operation for CNC Machining Centers
 32%

I

Process Planning
 3%

SECTION FOUR

TRADE MATH
 10%



A

Applied Mathematics
 58%

B

Applied Geometry
 42%

SECTION FIVE

PRINT READING
 11%



A

Interpret and Sketch Prints
 29%

B

Advanced Geometric Dimensioning and Tolerancing
 14%

C

Surface Texture (Finish) - Milling
 7%

D

Application of Limits and Fits
 14%

E

Computer Aided Design (CAD) and Computer Aided Manufacturing (CAM)
 29%

F

Assembly and Sub-Assembly Drawings
 7%

THIRD PERIOD
(8 Weeks 30 Hours per Week – Total of 240 Hours)

SECTION ONE

COMPUTER NUMERICAL CONTROL MACHINES (CNC)
 39%



A	B	C
Codes and Formats 6%	Linear and Circular Interpolation 4%	Canned Cycles 4%
D	E	F
Multiple Repetitive Cycles 9%	Tool Nose Radius Compensation 3%	CNC Threading 6%
G	H	I
Programming CNC Threads 6%	Tool Measurements 4%	Machine Operations 51%
J		
Multi Axis Turning 7%		

SECTION TWO

MACHINE TOOLS
 38%



A	B	C
Gearing 6%	Spur Gears 7%	Bevel Gears 5%
D	E	F
Helical Gears 4%	Gear Manufacturing Methods 13%	Multi Start and Worm Threading 13%
G	H	I
Abrasives 7%	Grinding Machines 27%	Machine Broaching 2%
J	K	
Splines 11%	Fixtures 5%	

SECTION THREE

TRADE MATH
 10%



A	B	C
Applied Mathematics 8%	Trigonometry Applications 42%	Advanced Limits and Fits 50%

SECTION FOUR

COMPUTER AIDED DESIGN AND MANUFACTURING
 13%

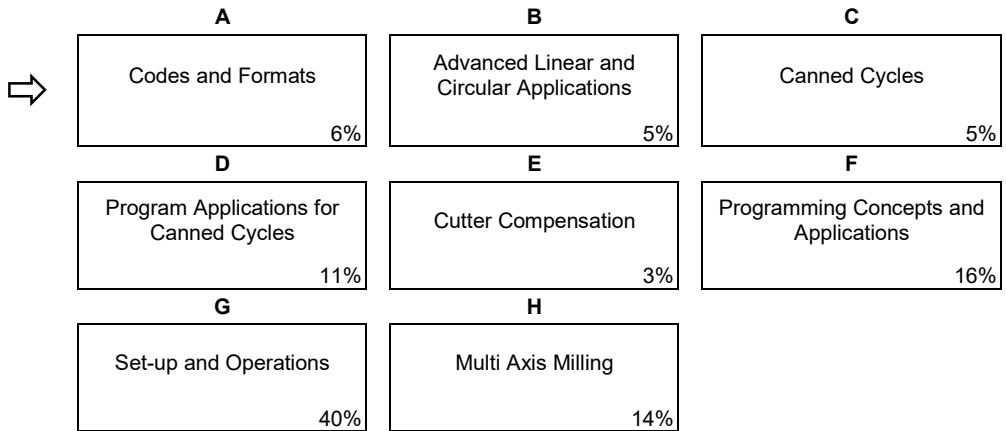


A	B	C
Computer Aided Design (CAD) 44%	Computer Aided Manufacturing (CAM) 44%	Co-ordinate Measuring Machining (CMM) 6%
D		
Advanced Process Planning - Estimating 6%		

FOURTH PERIOD
(8 Weeks 30 Hours per Week – Total of 240 Hours)

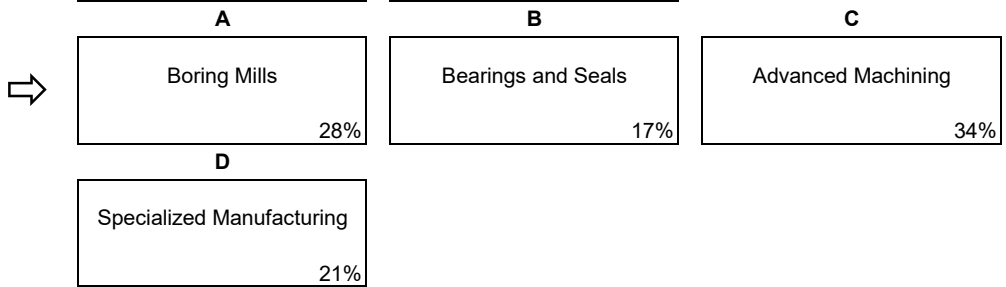
SECTION ONE

**COMPUTER NUMERICAL
CONTROL MACHINING
CENTERS** 53%



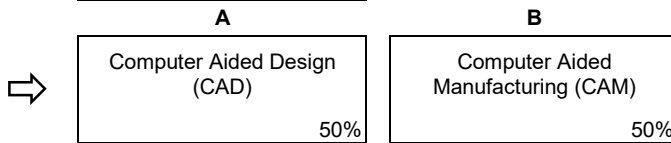
SECTION TWO

MACHINE TOOLS 24%



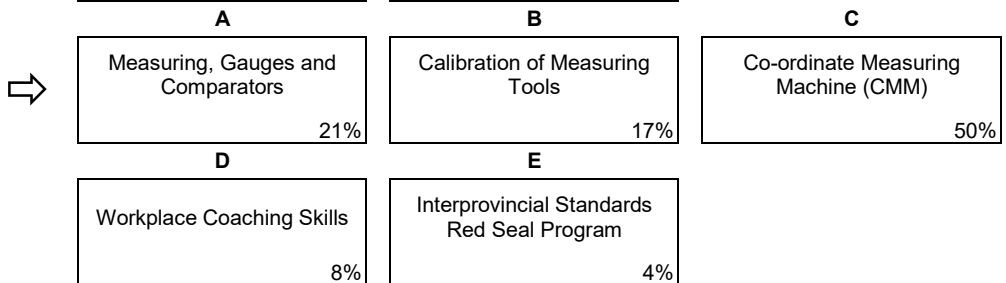
SECTION THREE

**COMPUTER AIDED DESIGN AND
MANUFACTURING** 13%



SECTION FOUR

**METROLOGY, COACHING &
GOVERNANCE** 10%



**FIRST PERIOD TECHNICAL TRAINING
MACHINIST TRADE
CURRICULUM GUIDE**

UPON SUCCESSFUL COMPLETION OF THIS PROGRAM THE APPRENTICE WILL BE ABLE TO PERFORM THE FOLLOWING OUTCOMES AND OBJECTIVES.

SECTION ONE:SAFETY AND MEASUREMENT 15%

A. Safety Legislation, Regulation & Industry Policy in the Trades6%

Outcome: *Apply legislation, regulations and practices ensuring safe work in this trade.*

1. Demonstrate the application of the Occupational Health and Safety Act, Regulation and Code.
2. Describe the sponsor's and employee's role with Occupational Health and Safety (OH&S) regulations, Worksite Hazardous Materials Information Systems (WHMIS), fire regulations, Workers Compensation Board regulations and related advisory bodies and agencies.
3. Describe industry practices for hazard assessment and control procedures.
4. Describe the responsibilities of worker and sponsors to apply emergency procedures.
5. Describe tradesperson attitudes with respect to housekeeping, personal protective equipment and emergency procedures.
6. Describe the roles and responsibilities of sponsors and employees with the selection and use of personal protective equipment (PPE).
7. Maintain required PPE for tasks.
8. Use required PPE for tasks.

B. Climbing, Lifting, Rigging and Hoisting6%

Outcome: *Use industry standard practices for climbing, lifting, rigging and hoisting in this trade.*

1. Describe manual lifting procedures.
2. Describe rigging hardware and associated safety factors.
3. Select equipment for rigging loads.
4. Describe hoisting and load moving procedures.
5. Maintain personal protective equipment (PPE) for climbing, lifting and load moving equipment.
6. Use PPE for climbing, lifting and load moving equipment.

C. Hazardous Materials & Fire Protection5%

Outcome: *Apply industry standard practices for hazardous materials and fire protection in this trade.*

1. Describe roles, responsibilities, features and practices related to the Workplace Hazardous Materials Information System (WHMIS) program.
2. Describe three key elements of WHMIS.
3. Describe handling, storing and transporting procedures for hazardous material.
4. Describe venting procedures when working with hazardous materials.
5. Describe hazards, classes, procedures and equipment related to fire protection.

D. Oxy-Fuel Equipment Safety 11%**Outcome: Demonstrate the use oxy-fuel equipment for heating and cutting operations.**

1. Describe the safety precautions and devices for oxy-fuel equipment.
2. Describe oxygen and fuel gas cylinders, regulators and the nature of gases.
3. Describe set-up, pressure and flame adjustment, and shutdown, for oxy-fuel equipment.
4. Set-up oxy-fuel equipment.
5. Demonstrate heat treatment and cutting operations.

E. Layout Tools and Procedures.....8%**Outcome: Demonstrate semi-precision and precision layout procedures.**

1. Describe the tools for layout procedures.
2. Describe the procedures for basic and precision layout.
3. Demonstrate layout procedures using layout tools.

F. Hand-Held Cutting Tools 17%**Outcome: Demonstrate the use of hand-held cutting tools common to the trade.**

1. Describe hacksaws and blades.
2. Describe parts, types, classification, shape and use of files.
3. Describe de-burring processes.
4. Describe taps and dies, stud and bolt removal tools, and the lubricant for these applications.
5. Describe hand reamers and hand broaching tools and their applications.
6. Describe the use of threaded inserts for thread repair operations.
7. Demonstrate the use of hand held cutting tools.

G. Measuring Tools..... 11%**Outcome: Measure workpieces using metric and imperial measuring tools.**

1. Describe basic measuring tools used in the machinist trade.
2. Describe precision measuring tools used in the machinist trade.
3. Describe the effects of temperature changes, with respect to measuring components.
4. Demonstrate the use and care of measuring tools.

H. Angular Measuring Tools8%**Outcome: Demonstrate measuring workpieces using angular measuring tools.**

1. Describe the use of dial indicators, gauge blocks for measurement.
2. Describe the use of sine bars and of sine plates.
3. Describe the use of precision squares.
4. Describe the use of a bevel and plate and universal bevel protractors.
5. Demonstrate the use of angular measurement tools.

I. Screw Thread Terminology 14%

Outcome: *Describe screw thread terminology.*

1. Describe screw thread forms and their applications.
2. Describe the parts of external and internal screw threads.
3. Describe terminology associated with thread classification and fits.
4. Determine screw thread tolerances from charts and tables.

J. Screw Thread Measuring and Gauging8%

Outcome: *Demonstrate screw thread inspection methods.*

1. Demonstrate screw thread calculations for 60° thread forms.
2. Demonstrate the methods used to accurately measure and gauge threads.

K. Inspection Gauges6%

Outcome: *Demonstrate the use of inspection gauges.*

1. Describe types of inspection gauges.
2. Demonstrate the use of inspection gauges.

SECTION TWO:MACHINE TOOLS..... 58%

A. Hand Grinding Machines6%

Outcome: *Demonstrate the use of offhand grinding.*

1. Describe the safety precautions when using offhand grinders.
2. Describe types of off-hand grinding machines.
3. Describe grinding wheels and their uses.
4. Describe the installation, trueing and dressing of grinding wheels.
5. Demonstrate maintenance and operation of offhand grinders.

B. Power Saws2%

Outcome: *Demonstrate the operation of power saws.*

1. Describe the safety precautions when using power saws.
2. Describe the types, design features, and applications of power saws.
3. Describe the selection of saw blades and cut-off wheels.
4. Demonstrate the use of power saws.

C. Speeds, Feeds and Cutting Tools6%

Outcome: *Describe the cutting conditions for turning operations.*

1. Describe the composition and characteristics of cutting tool materials.
2. Describe shapes, angles and clearances used when grinding a cutting tool.
3. Calculate turning speeds and feeds for cutting tool and workpiece materials.
4. Describe how variables such as machinability, rigidity and depth of cut affect speeds and feeds.
5. Select carbide insert shapes for turning applications.

6. Demonstrate the angles and clearances used when grinding a cutting tool.
7. Demonstrate the application of feed, speed, and depth of cut for turning operations.
8. Demonstrate the cutting conditions for threading.

D. Drilling Machines 11%

Outcome: *Demonstrate the use of drilling machines.*

1. Describe the safety precautions when using drilling machines.
2. Describe the types, parts attachments and operation of drilling machines.
3. Describe tool and work holding devices.
4. Describe parts of a twist drill and the types of twist drill materials.
5. Describe special types of drills and reamers.
6. Describe metric, fractional, letter and number drill sizes and methods of measuring drill sizes.
7. Demonstrate the procedures for grinding a drill bit.
8. Demonstrate the techniques used to correct drilling issues.
9. Calculate the correct speeds and feeds for drill press operations.
10. Demonstrate drilling operations using drilling machines and attachments.

E. Lathes4%

Outcome: *Describe the sizing, parts, accessories and attachments of lathes.*

1. Describe the safety precautions when using lathes.
2. Describe the types, size and rated capacity of lathes.
3. Describe major parts of a lathe and their functions.
4. Describe work holding devices used on the lathe.
5. Describe tool posts and cutting tool holders.

F. Lathe Attachments and Accessories7%

Outcome: *Demonstrate the use of lathe attachments and accessories during lathe operations.*

1. Describe the set-up and application of attachments and accessories used on the lathes.
2. Describe the use of steady rests, follower rests, mandrels and turning between centers.
3. Demonstrate the use of attachments and accessories for lathes.

G. Lathe Operations 42%

Outcome: *Demonstrate lathe set-up and operation.*

1. Set-up the cutting tool to perform parallel turning and boring operations.
2. Operate a lathe to turn to a shoulder.
3. Demonstrate center drilling, drilling and reaming operations.
4. Demonstrate the set-up and cutting of a taper on a lathe.
5. Demonstrate knurling, grooving, parting-off, forming and profiling, on a lathe.
6. Demonstrate the use of taps, dies, and single point tools to cut a thread.
7. Demonstrate set-ups for different operations on a lathe.

H. Machine Lubrication and Cutting Fluids2%

Outcome: Demonstrate the application of lubricants.

1. Describe the health hazards associated with cutting fluids.
2. Describe the characteristics and functions of cutting fluids.
3. Describe methods used to apply cutting fluids.
4. Describe lubrication schedules from manufacturer's specifications.

I. Introduction and Application of Computer Numerical Control (CNC) Turning Machines1%

Outcome: Describe basic concepts and applications of CNC machines.

1. Describe safety practices when using CNC machines.
2. Describe basic operational codes used in CNC programming and machining.
3. Describe basic types and applications for horizontal and vertical CNC turning centers.
4. Describe the advantages and disadvantages of CNC machines.

J. Machine Coordinate Systems for CNC Turning Machines1%

Outcome: Describe the purpose of co-ordinate and reference points used for CNC lathe programs.

1. Describe coordinate points of a workpiece using absolute and incremental values.
2. Describe the CNC lathe axis system.
3. Describe the purpose for reference points used on CNC turning centers.

K. Parts and Workholding Accessories for CNC Turning Machines1%

Outcome: Describe the basic parts and workholding accessories for CNC turning centers.

1. Describe the parts, functions and features of CNC turning centers.
2. Describe chucks and collets used on CNC turning centers.
3. Describe the safety practices when using CNC workholding accessories.
4. Demonstrate use of chucks and collets on CNC turning centers.

L. Set-up and Operation for CNC Turning Machines 17%

Outcome: Demonstrate the set-up and operation for turning centers.

1. Describe the purpose of the major components and features of a typical CNC operator panel.
2. Describe methods of inputting, sorting and verifying CNC programs.
3. Describe the process and procedure for tooling set-up.
4. Describe the purpose and use of tool offsets.
5. Demonstrate tool set-up.
6. Demonstrate tool offset procedures.
7. Demonstrate overriding cutting conditions on turning centers.
8. Execute a CNC turning program.

SECTION THREE: TRADE MATH 14%

A. Working with Numbers 13%**Outcome: Perform mathematical operations with whole numbers.**

1. Read whole numbers by using place values and perform rounding operations.
2. Perform addition and subtractions with whole numbers.
3. Perform multiplication and divisions with whole numbers.
4. Identify and perform operations with signed numbers.

B. Fractions and Decimals and Percentages 13%**Outcome: Solve problems involving fractions and decimals.**

1. Identify key terms and concepts used when working with fractions.
2. Convert fractions mixed numbers and vice versa.
3. Identify common denominators.
4. Perform basic mathematical operations using fractions.
5. Solve problems using decimal numbers, fractions and mixed numbers.
6. Round whole numbers and decimals to specified place values.
7. Describe the relationship between decimal numbers, fractions and percentages.
8. Convert decimal numbers, fractions and percentages.

C. Algebra 19%**Outcome: Perform mathematical operations using algebra.**

1. Describe algebraic functions.
2. Demonstrate the order of algebraic operations.
3. Demonstrate the ability to manipulate equations.
4. Solve problems using algebraic formulas.

D. Measurement and Conversions 12%**Outcome: Solve problems involving measurement and conversion.**

1. Describe the basic units for length, mass, area, volume and temperature in both the imperial and metric (SI) systems.
2. Solve problems using the basic units from both imperial and metric systems.
3. Convert from imperial to metric and metric to imperial measurements.

E. Ratio and Proportion9%**Outcome: Solve problems using ratio and proportion.**

1. Describe two quantities in the form of a ratio.
2. Describe two ratios in the form of a proportion.
3. Solve problems using ratio and proportion.

F. Taper Systems9%**Outcome: Apply taper systems to machining operations.**

1. State four applications of tapers.

2. Identify the individual parts of a taper.
3. Describe methods used to measure or gauge an external or internal taper for fit and accuracy.
4. Identify eight taper systems and their applications.
5. Perform calculations for both metric and imperial tapers.

G. Introduction to Triangles and Trigonometry 25%

Outcome: Solve problems involving triangles and elementary trigonometry.

1. Describe the terms and concepts used in working with triangles.
2. Describe special triangles and solve problems using related formulas.
3. Describe Pythagorean Theorem and solve problems.
4. Describe the terms and concepts associated with trigonometry.
5. Use trigonometric formulae to determine missing triangular data.

SECTION FOUR: PRINT READING 13%

A. Introduction to Print Reading 25%

Outcome: Sketch basic components.

1. Describe the planes of an orthographic projection.
2. Describe first and third angle projections, and recognize the ISO symbol for each projection.
3. Describe the types of lines used on prints and their applications.
4. Apply basic rules to dimensions on a component drawing.
5. Sketch and dimension simple objects in orthographic projection.

B. Dimensioning Methods 6%

Outcome: Describe methods of dimensioning on a print.

1. Describe the methods of applying dimensions to a print.
2. Describe methods used to express the amount of taper on a component drawing.
3. Interpret dimensions on prints in either metric and imperial systems or dual dimensioning.
4. Calculate unspecified dimensions on a drawing.

C. Sections 6%

Outcome: Describe the technical elements of break lines and sectional representation.

1. Describe cutting plane lines, break lines and symmetry and their application.
2. Describe the use of sectional views and their applications.

D. Isometric Drawings 6%

Outcome: Sketch pictorial drawings.

1. Describe types of pictorial views.
2. Interpret isometric drawings.

E. Surface Texture (Finish) - Turning 10%**Outcome: Describe concepts related to surface texture.**

1. Describe terms related to the production and measurement of surface textures.
2. Describe surface texture symbols used to indicate surface finish values.
3. Demonstrate machining or finishing process to produce a given surface texture.

F. Introduction to Geometric Dimensioning and Tolerancing 10%**Outcome: Interpret geometric dimensioning and tolerancing.**

1. Describe the terminology and purpose used in geometric dimensioning and tolerancing.
2. Describe basic symbols used in geometric dimensioning and tolerancing.
3. Verify geometric dimensioning and tolerancing on parts.

G. Introduction to Limits and Fits6%**Outcome: Describe limits and fits used in machining.**

1. Describe the terminology and purpose of limits and fits.
2. Interpret limits and fits on prints.
3. Calculate allowances on mating parts.

H. Introduction to Computer Aided Design (CAD) and Computer Aided Manufacturing (CAM) 25%**Outcome: Describe the basics of CAD and CAM for turning.**

1. Describe the terminology and processes associated with CAD and CAM.
2. Generate geometry for basic turning processes.
3. Apply and verify tool paths for basic turning geometry.
4. Post process the tool path for a basic turning program.

I. Fasteners and Locking Devices6%**Outcome: Describe the uses for threaded and non-threaded fasteners.**

1. Describe threaded fasteners and their applications.
2. Describe non-threaded fasteners and their applications.

**SECOND PERIOD TECHNICAL TRAINING
MACHINIST TRADE
CURRICULUM GUIDE**

UPON SUCCESSFUL COMPLETION OF THIS PROGRAM THE APPRENTICE WILL BE ABLE TO PERFORM THE FOLLOWING OUTCOMES AND OBJECTIVES.

SECTION ONE:..... METALLURGY AND HEAT TREATMENT..... 8%

A. Ferrous Metals 33%

Outcome: *Select the type of ferrous metals for an application.*

1. Describe the physical and mechanical properties of ferrous metals.
2. Describe alloying as a factor that changes physical and mechanical properties.
3. Describe heat-treating processes and the terminology associated with them.
4. Describe the characteristics of ferrous metals for machining operations.
5. Demonstrate the use of the classification system to identify metals.

B. Non-Ferrous Metal 33%

Outcome: *Select the type of non-ferrous metals for an application.*

1. Describe the physical and mechanical properties of non-ferrous metals.
2. Describe the applications and mechanical properties of alloys.
3. Describe the characteristics of non-ferrous metals and alloys for machining operations.
4. Demonstrate the use of the classification system to identify metals.

C. Metal Specifications and Testing 34%

Outcome: *Describe metal specifications and testing.*

1. Interpret charts and tables to select a metal for an application.
2. Describe methods of destructive testing of metals.
3. Describe methods of non-destructive testing of metals.
4. Describe aspects of material test reports (MTR).

SECTION TWO:..... TOOLING 7%

A. Tool and Work Holding Devices 13%

Outcome: *Select the proper tool and work holding device for a milling operation.*

1. Describe tool holding devices and their applications for the milling machine.
2. Describe work holding devices and their applications for the milling machine.

B. Milling Cutters 25%

Outcome: *Select a cutter for a milling application.*

1. Describe the types of materials used in the construction of milling cutters, their applications and limitations.

2. Describe the types of cutters used for horizontal milling operations.
3. Describe the types of cutters used for vertical milling machine operations.
4. Describe the care and handling of milling cutters.

C. Cutting Tool Materials 25%

Outcome: *Describe chip formation, characteristics of cutting tool materials, methods of manufacture and applications.*

1. Describe the mechanics of chip formation.
2. Describe cutting tool materials and their manufacture.
3. Describe the application of different cutting tool materials.

D. Inserts and Tool Holders..... 37%

Outcome: *Describe inserts and tool holders.*

1. Describe cutting tool geometry and its purpose.
2. Select carbide inserts and tool holders from charts.
3. Describe carbide tool failure and troubleshooting.
4. Demonstrate the replacement of inserts and tool holder hardware.

SECTION THREE: MACHINE TOOLS 64%

A. Milling Machines 3%

Outcome: *Describe the types, size, parts, accessories and attachments of milling machines.*

1. Describe the safety precautions when using milling machines.
2. Describe type, size, and rated capacity of milling machines.
3. Describe the parts of milling machines and their functions.
4. Describe milling accessories and their applications.

B. Milling Operations..... 38%

Outcome: *Demonstrate the set-up and operation of a milling machine.*

1. Describe conventional and climb milling.
2. Describe plain milling and face milling.
3. Describe the set-up for cutting slots and keyseats.
4. Describe the set-up for using a slitting saw.
5. Describe the set-up for drilling and boring on a milling machine.
6. Describe the set-up for straddle, gang and form milling.
7. Describe the set-up for milling T-slots and dovetails.
8. Demonstrate the set-up of tool holding devices for milling machines.
9. Demonstrate the set-up and operations on milling machines.
10. Calculate the cutting speed, feed and depth of cut for cutting tool and workpiece materials.
11. Select an insert for milling applications.

C. Dividing Head and Indexing..... 3%

Outcome: *Describe methods of indexing using a dividing head.*

1. Describe the applications of a dividing head, and each individual part.
2. Describe direct, simple and angular methods of indexing.
3. Describe the use of a rotary table.

D. Threading..... 13%

Outcome: *Describe the types and uses of multiple start threads, translational threads, and taper threads.*

1. Describe the purpose of multiple start threads.
2. Describe the types and uses of translational threads.
3. Describe types and uses of rotary shoulder and taper threads.
4. Demonstrate cutting screw thread forms with single point tools.

E. Program and Machine Co-ordinate Systems for CNC Machining Centers 1%

Outcome: *Describe the purpose of co-ordinate and reference points used for CNC milling programs.*

1. Describe co-ordinate points of a workpiece using absolute and incremental values.
2. Describe the purpose of the CNC machining center axis system.
3. Describe the purpose for reference points used on CNC machining centers.

F. Parts for CNC Machining Centers 3%

Outcome: *Describe basic parts for CNC machining centers.*

1. Describe the parts, functions and features of CNC machining centers.
2. Describe workholding devices for CNC machining centers.
3. Describe safety practices when using CNC workholding accessories.

G. Programming Concepts and Codes for CNC Machining Centers 4%

Outcome: *Describe programming concepts and codes.*

1. Describe elements of a CNC milling program.
2. Describe the purpose of preparatory (G) and miscellaneous (M) codes.
3. Describe tool, feed rate, speed and related program commands.
4. Describe tool and workpiece co-ordinates, and related program codes.
5. Create a basic CNC milling program.

H. Set-up and Operation for CNC Machining Centers 32%

Outcome: *Demonstrate the set-up and operation for machining centers.*

1. Describe the features on the operator’s panel of a machining center.
2. Describe the process and procedure for tooling set-up.
3. Describe the purpose and use of tool offsets.
4. Describe cutting conditions on machining centers.

5. Demonstrate tool offset procedures.
6. Demonstrate tool set-up.
7. Demonstrate the execution of a CNC machining program.

I. Process Planning..... 3%

Outcome: *Describe the reasonable sequence of events necessary to complete a job.*

1. Describe the planning process to complete a job.
2. Develop a plan to complete a job.

SECTION FOUR: TRADE MATHEMATICS..... 10%

A. Applied Mathematics 58%

Outcome: *Apply mathematics using calculations, tables and charts.*

1. Perform calculations on practical applications involving triangle theory and methods.
2. Perform calculations on practical applications involving ratio and proportion formula.
3. Using the Machinery’s Handbook read and interpret tables, charts and graphs.
4. Calculate simple mechanical forces.

B. Applied Geometry 42%

Outcome: *Apply geometry in calculation and problem solving.*

1. Describe terminology and shapes associated with common geometric forms.
2. Describe formulae to determine the size of common geometric forms.
3. Apply trigonometric formulas to solve problems.
4. Determine circle feature values through calculation.
5. Calculate thread geometry.

SECTION FIVE: PRINT READING 11%

A. Interpret and Sketch Prints..... 29%

Outcome: *Interpret and sketch prints containing advanced technical information.*

1. Identify accumulation of tolerances.
2. Apply dimensions to tapers on sketching exercises.
3. Sketch and dimension technical element such as threads, boxes and countersinks.
4. Sketch and interpret a component in orthographic projection having an auxiliary view.
5. Sketch a pictorial drawing showing inclined surfaces, tapers and other technical elements.

B. Advanced Geometric Dimensioning and Tolerancing 14%

Outcome: *Interpret geometric dimensioning and tolerancing (GD&T).*

1. Describe terminology and symbols used in geometric dimensioning and tolerancing.
2. Verify geometric dimensioning and tolerancing on parts.

C. Surface Texture (Finish) – Milling 7%

Outcome: *Describe concepts related to surface texture.*

1. Describe how different machining processes affect the lay.
2. Demonstrate how to measure a surface texture on a workpiece.
3. Demonstrate machining or finishing process to produce a given surface texture.

D. Application of Limits and Fits 14%

Outcome: *Describe interchangeability between machined parts through the application of standards of limits and fits.*

1. Describe the terminology related to standards of limits and fits.
2. Describe the application of standards of limits and fits to machined parts.

E. Computer Aided Design (CAD) and Computer Aided Manufacturing (CAM) 29%

Outcome: *Describe the basics of CAD and CAM for milling.*

1. Describe the terminology and processes associated with CAD and CAM.
2. Create geometry for a basic milling process.
3. Apply and verify tool paths for basic milling geometry.
4. Post process the tool path for a basic milling program.

F. Assembly and Sub-Assembly Drawings 7%

Outcome: *Define the purpose of assembly drawings.*

1. Interpret part identification methods and bill of material on assembly drawings.
2. Interpret information found on assembly drawings and sub-assembly drawings.

**THIRD PERIOD TECHNICAL TRAINING
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CURRICULUM GUIDE**

UPON SUCCESSFUL COMPLETION OF THIS PROGRAM THE APPRENTICE WILL BE ABLE TO PERFORM THE FOLLOWING OUTCOMES AND OBJECTIVES.

SECTION ONE:..... COMPUTER NUMERICAL CONTROL MACHINES (CNC)..... 39%

A. Codes and Formats 6%

Outcome: **Describe CNC concepts, programming codes and applications for turning centers.**

1. Describe CNC concepts and terminology.
2. Describe the components of typical program formats.
3. Describe the block-skip function.
4. Set up and operate a CNC turning center using G, M, S, T and F codes.

B. Linear and Circular Interpolation 4%

Outcome: **Program and apply linear and circular tool path motions for workpieces.**

1. Describe the programming elements of linear tool path motions (linear interpolation) for turning operations.
2. Describe the programming elements of circular interpolation for turning operations.
3. Demonstrate the use of arc modifiers for circular interpolation.
4. Create a CNC lathe program including linear and circular tool path motions.

C. Canned Cycles 4%

Outcome: **Create a CNC program using canned cycles for facing, turning and boring operations.**

1. Describe the application of canned cycles for turning, facing and boring.
2. Demonstrate the use of canned cycles for square and tapered facing operations.
3. Demonstrate the use of canned cycles for cylindrical and tapered turning operations.
4. Demonstrate the use of canned cycles for cylindrical and tapered boring operations.

D. Multiple Repetitive Cycles 9%

Outcome: **Demonstrate repetitive machining cycles for turning, boring, facing, radial and face grooving, and drilling operations.**

1. Describe the application of multiple repetitive machining cycles.
2. Demonstrate the use of turning and boring repetitive cycles.
3. Demonstrate the use of facing repetitive cycles.
4. Demonstrate the use of pattern repeating repetitive cycles for pre-shaped forgings and castings.
5. Demonstrate the use of repetitive cycles for radial grooving operations.
6. Demonstrate the use of repetitive cycles for face grooving operations.
7. Demonstrate the use of repetitive cycles for drilling operations.

E. Tool Nose Radius Compensation (TNRC)..... 3%

Outcome: Demonstrate the use of TNRC for CNC turning operations.

1. Describe the purpose of TNRC for turning operations.
2. Describe vector direction for TNRC.
3. Demonstrate G40, G41 and G42 codes used in TNRC for turning operations.

F. CNC Threading..... 6%

Outcome: Perform the calculations required for programming threading cycles.

1. Describe the terminology associated with threading cycles.
2. Describe tool infeed and retraction methods for threading.
3. Describe applications for acceleration, deceleration and offset distances.
4. Describe the cutting conditions for threading.
5. Determine the infeed, accumulative infeed and starting positions for RH and LH threading.

G. Programming CNC Threads..... 6%

Outcome: Develop CNC threading programs.

1. Select inserts and tooling for threading operations.
2. Demonstrate canned and repetitive cycles for cylindrical threading operations.
3. Demonstrate threading cycles for tapered threading operations.
4. Demonstrate programming for multiple start threads.
5. Demonstrate programming for tapping operations.
6. Identify common threading problems, causes and solutions.

H. Tool Measurements 4%

Outcome: Describe terms, concepts and tool measuring methods used on CNC turning centers.

1. Describe the terms and concepts used in tool measurement and offsets.
2. Demonstrate the programming application of vector direction and radius values.
3. Demonstrate tool measurement using a master reference tool and workshift.
4. Demonstrate automatic tool measurements using a qualified tool setter and workshift.

I. Machine Operations 51%

Outcome: Demonstrate control features and functions for machine set-up and operations.

1. Describe the control features and functions for turning operations.
2. Demonstrate program input, storage, editing and verification.
3. Demonstrate tool set-up on a CNC turning center.
4. Set up and execute a program on a CNC turning center.

J. Multi Axis Turning..... 7%

Outcome: Demonstrate live tooling set-up and operations.

1. Describe the purpose and use of C and Y axis.

2. Describe the purpose and use of multi spindle turning center.
3. Describe the purpose and use of multi turret turning centers.
4. Demonstrate the set-up and operation of live tooling.

SECTION TWO:..... MACHINE TOOLS 38%

A. Gearing 6%

Outcome: Describe basic gear operation and applications.

1. Describe types of gears and their applications.
2. Describe the purpose of the five standard gear tooth pressure angles.
3. Calculate the speed and gear ratios for simple and compound gears.

B. Spur Gears..... 7%

Outcome: Describe indexing and spur gears.

1. Describe the terminology associated with each part of a spur gear.
2. Spur gear calculations.
3. Demonstrate set-up and cutting of a spur gear.

C. Bevel Gears 5%

Outcome: Describe the elements and applications of bevel gears.

1. Describe the types and applications of bevel gears.
2. Describe the main elements of bevel gears.

D. Helical Gears 4%

Outcome: Describe the elements and applications of helical gears.

1. Identify the main elements of helical gears.
2. Identify applications for helical gears, as well as their advantages and disadvantages.

E. Gear Manufacturing Methods 13%

Outcome: Describe the process of manufacturing precision gear systems.

1. Calculate the required dimensions when cutting a spur gear and rack.
2. Describe methods of manufacturing and finishing gears.
3. Describe the inspection methods used to measure the design specifications on gears.
4. Demonstrate the set-up for hobbing a gear on a milling machine.

F. Multi Start and Worm Threading 13%

Outcome: Perform calculations and operations for multi start and worm threading.

1. Describe the basic elements of plain, single enveloping, and double enveloping worm threads.
2. Describe the methods and materials used in the manufacture of worm threads.
3. Calculate the size of the basic elements.
4. Describe the characteristics and applications of multiple start threads.
5. Demonstrate the set-up and perform multi start thread cutting on the lathe.

G. Abrasives..... 7%

Outcome: Describe abrasives and their uses.

1. Describe types and uses of abrasives.
2. Describe grinding wheel nomenclature and types.
3. Select a grinding wheel for specific applications.

H. Grinding Machines..... 27%

Outcome: Demonstrate grinding machines and processes.

1. Describe the types, parts, holding devices and operation of surface and cylindrical grinders.
2. Describe the purpose of truing and dressing grinding wheels.
3. Demonstrate the mounting and truing of grinding wheels.
4. Demonstrate balancing and dressing operations on grinding wheels.
5. Demonstrate grinding operations on grinders.

I. Machine Broaching..... 2%

Outcome: Demonstrate broaches and broaching machines.

1. Describe the design and application of broaches.
2. Set-up and perform broaching operations.

J. Splines 11%

Outcome: Describe methods for producing splines.

1. Describe the types of splines and their applications.
2. Describe the methods and fits of manufacturing splines.
3. Demonstrate manufacturing of straight sided splines.

K. Fixtures 5%

Outcome: Describe the design and application of fixtures.

1. Describe the design principles and applications of fixtures.
2. Describe locating and clamping devices of fixtures.
3. Demonstrate the use and application of fixtures.

SECTION THREE: TRADE MATHEMATICS..... 10%

A. Applied Mathematics 8%

Outcome: Perform calculations.

1. Solve problems by interpreting and using data from tables, charts and graphs found in the Machinery's Handbook.

B. Trigonometry Applications 42%

Outcome: Perform calculations using trigonometry.

1. Solve problems for parts of different triangles.
2. Use trigonometry to solve machining problems.

C. Advanced Limits and Fits 50%

Outcome: Design a GO/NO GO inspection gauge.

1. Calculate fits and dimensions for designing gauges.
2. Describe implications of surface finishes and GD&T.
3. Design a GO/NO GO inspection gauge.

SECTION FOUR: COMPUTER AIDED DESIGN AND COMPUTER AIDED MANUFACTURING..... 13%

A. Computer Aided Design (CAD)..... 44%

Outcome: Demonstrate a CAD drawing for turning.

1. Create the geometry for grooving, threading and profiling applications.
2. Edit imported CAD drawings.

B. Computer Aided Manufacturing (CAM) 44%

Outcome: Demonstrate tool path generation for turning, including live tooling.

1. Apply and verify tool paths for advanced turning processes.
2. Create a tool library.
3. Demonstrate use of live tooling / C-axis for CAM processes.

C. Co-ordinate Measuring Machine Technology (CMM)..... 6%

Outcome: Describe Co-ordinate Measuring Machine Technology (CMM)

1. Describe Co-ordinate Measuring Machine Technology.
2. Describe the function, parts and use of CMM's.
3. Demonstrate how a CMM is used to accurately measure components.

D. Advanced Process Planning – Estimating 6%

Outcome: Use a machine shop estimating process.

1. Describe the terms and concepts related to estimating.
2. Determine the cost of materials for a job.
3. Determine the cost of labour for a job.
4. Perform a final cost estimate for a job.

**FOURTH PERIOD TECHNICAL TRAINING
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UPON SUCCESSFUL COMPLETION OF THIS PROGRAM THE APPRENTICE WILL BE ABLE TO PERFORM THE FOLLOWING OUTCOMES AND OBJECTIVES.

SECTION ONE:..... COMPUTER NUMERICAL CONTROL MACHINING CENTERS 53%

A. Codes and Formats 6%

Outcome: *Describe CNC concepts, programming codes and applications for machining centers.*

1. Describe CNC concepts and terminology.
2. Describe the components of typical program formats.
3. Set up and operate a CNC machining center using G, M, S, T and F codes.
4. Demonstrate the use of workshift and tool length offset program codes.

B. Advanced Linear and Circular Interpolation..... 5%

Outcome: *Demonstrate linear and circular interpolation for profile milling operations.*

1. Describe the elements of linear tool path motions (linear interpolation) for milling operations.
2. Describe elements of circular interpolation for milling operations.
3. Write a CNC program including linear and circular tool path motions for machining centers.
4. Demonstrate the use of arc modifiers for circular interpolation.

C. Canned Cycles 5%

Outcome: *Demonstrate canned cycles used for drilling, boring and tapping operations performed on CNC machining centers.*

1. Describe program variables used in canned cycles.
2. Describe the use of drilling, tapping and boring canned cycles.

D. Program Applications for Canned Cycles..... 11%

Outcome: *Demonstrate canned cycle programs for hole making operations for CNC machining centers.*

1. Calculate co-ordinate points for typical hole patterns.
2. Calculate depth of holes for drilling operations.
3. Demonstrate canned cycles for drilling type operations including tapping and boring.
4. Demonstrate canned cycles with repeat (L) function for linear and grid hole patterns.
5. Demonstrate canned cycles using polar co-ordinates.

E. Cutter Compensation 3%

Outcome: *Demonstrate cutter compensation for machining workpiece profiles on CNC machining centers.*

1. Describe the purpose of cutter compensation for milling operations.

2. Describe program codes, machine settings and guidelines for cutter compensation.
3. Demonstrate G40, G41 and G42 codes used in cutter compensation for milling operations.

F. Programming Concepts and Applications 16%

Outcome: Describe advanced programming concepts and applications.

1. Describe concepts for macro programming.
2. Describe mirror image for machining applications.
3. Describe co-ordinate rotation for machining applications.
4. Demonstrate workpiece coordinate system shift programming techniques.
5. Demonstrate the use of subprograms for appropriate machining applications.
6. Demonstrate helical milling for hole making and thread milling operations.

G. Set-Up and Operations 40%

Outcome: Demonstrate machining operations on CNC machining centers.

1. Demonstrate loading of tools, input tool numbers and tool geometry.
2. Demonstrate the sequence of operations for tool changers.
3. Demonstrate tool length and tool length offset measurements.
4. Demonstrate workpiece co-ordinate or workshift measurements.
5. Execute a program on a computer numerically controlled machining center.

H. Multi Axis Milling..... 14%

Outcome: Set-up and operate a fourth axis.

1. Describe fourth axis machining.
2. Describe multi axis machining.
3. Set up and operate fourth axis milling.

SECTION TWO: MACHINE TOOLS 24%

A. Boring Mills 28%

Outcome: Demonstrate operations performed on boring mills.

1. Describe safety, types, parts, and controls of horizontal and vertical boring mills.
2. Describe accessories, operations, speeds and feeds of boring mills.
3. Demonstrate set-up and perform boring operations on a boring mill.

B. Bearings and Seals..... 17%

Outcome: Describe the selection and installation of bearings and seals.

1. Describe the types and applications of plain bearings.
2. Describe the types and applications of roller bearings.
3. Describe bearing installation and fits.
4. Describe types and applications of seals.
5. Demonstrate machining of bearing journals.

C. Advanced Machining 34%**Outcome: Demonstrate critical set-up of rotating components.**

1. Apply geometric dimensioning and tolerancing on machining applications.
2. Use work holding devices in machining operations.
3. Demonstrate repair procedures for parts and components.
4. Apply geometric dimensioning and tolerancing on parts and components for a gearbox.
5. Demonstrate procedures for critical alignment of components.

D. Specialized Manufacturing 21%**Outcome: Describe non-traditional process used in manufacturing.**

1. Describe the processes and applications of electrochemical machining to remove metal.
2. Describe the use of thermal processes for machining metal.
3. Describe the process and applications of powder metallurgy for the mass production of parts.
4. Describe methods of deep-hole drilling and their applications.
5. Discuss new technological advancements that are relevant to manufacturing processes.
6. Describe safety practices when using Electrical Discharge Machining (EDM).
7. Describe the function, parts and accessories of EDM's.
8. Describe portable machining.

SECTION THREE: COMPUTER AIDED DESIGN AND MANUFACTURING 13%**A. Computer Aided Design (CAD) 50%****Outcome: Demonstrate CAD drawing for milling.**

1. Create the geometry for advanced machining processes.
2. Edit imported CAD drawings.

B. Computer Aided Manufacturing (CAM) 50%**Outcome: Demonstrate tool path generation for milling.**

1. Apply and verify the tool path for advanced milling processes.
2. Demonstrate the use of 4th axis in CAM processes.

SECTION FOUR: METROLOGY, COACHING AND GOVERNANCE 10%**A. Measuring, Gauges and Comparators 21%****Outcome: Describe inspection gauges and comparators for indirect measurement.**

1. Describe inspection gauges and comparators.
2. Describe methods of comparison measurement.
3. Demonstrate how to use precision measuring systems to measure flatness and surface finish.

B. Calibration of Measuring Tools 17%

Outcome: *Describe methods of checking and calibrating precision measuring tools.*

1. Describe a system for determining the accuracy of micrometers and dial indicators using gauge blocks.
2. Describe methods of determining whether a gauge is within tolerances.

C. Co-ordinate Measuring Machine (CMM) 50%

Outcome: *Demonstrate Co-ordinate Measuring Machine Technology (CMM)*

1. Describe advanced functions of a CMM.
2. Demonstrate how a CMM is used to accurately measure milled components.

D. Workplace Coaching Skills 8%

Outcome: *Use coaching skills when training an apprentice.*

1. Describe the process for coaching an apprentice.

E. Interprovincial Standards Red Seal Program 4%

Outcome: *Use Red Seal products to challenge an Interprovincial examination.*

1. Identify Red Seal products used to develop Interprovincial examinations.
2. Use Red Seal products to prepare for an Interprovincial examination.



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