



**Skilled
Trades**
Ontario

**Métiers
spécialisés**
Ontario

Apprenticeship
Curriculum Standard

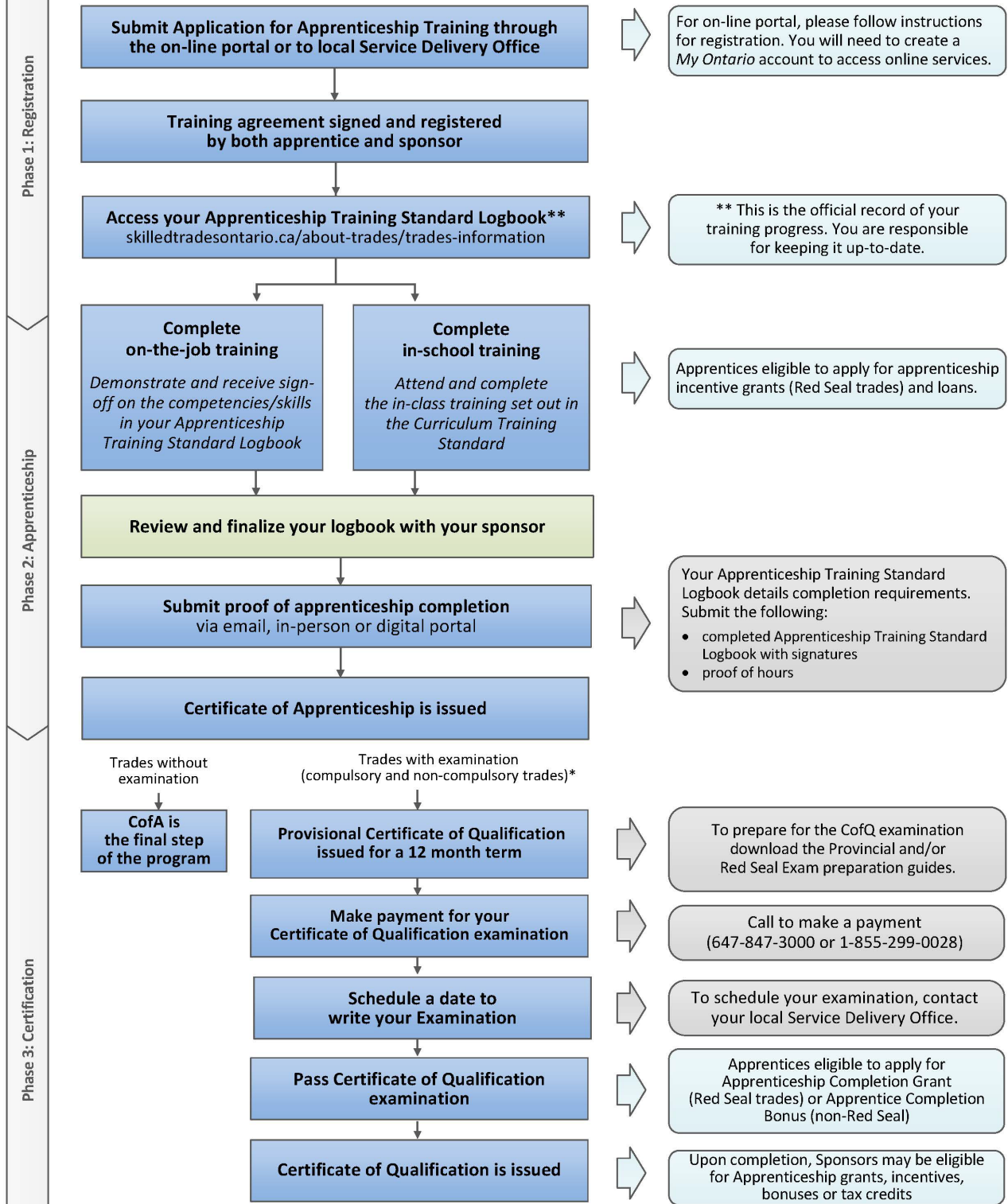
Tool and Die Maker
Tool/Tooling Maker

Level 2 Intermediate

430A & 630T

2008

Apprenticeship Pathway to a Certificate of Qualification



* For a list of trades subject to a certification examination, visit: skilledtradesontario.ca

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Please Note: This Standard has been revised to reflect the visual identity of Skilled Trades Ontario (STO) which replaced the Ontario College of Trades on January 1, 2022. The content of this Standard may refer to the former organization; however, all trade specific information or content remains relevant and accurate based on the original date of publishing.

Please refer to STO's website: skilledtradesontario.ca for the most accurate and up to date information. For information about BOSTA and its regulations, please visit [Building Opportunities in the Skilled Trades Act, 2021 \(BOSTA\)](#).

Any updates to this publication are available on-line; to download this document in PDF format, please follow the link: Skilled Trades Ontario.ca.

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Maintained with transfer to Skilled Trades Ontario 2008 (V100)

Preface

This curriculum standard for the Tool and Die Maker and Tool/Tooling Maker trade programs is based upon the on-the-job performance objectives, located in the industry-approved training standard.

This is the second level of 3 levels of training. The Reportable Subjects Summary chart (located on page 3) summarizes the training hours for each reportable subject.

The curriculum identifies the learning that takes place in-school. The in-school program focuses primarily on the theoretical knowledge and the essential skills required to support the performance objectives of the Apprenticeship Training Standards.

Employers/Sponsors are expected to extend the apprentice's knowledge and skills through practical training on a work site. Regular evaluations of the apprentice's knowledge and skills are conducted throughout training to verify that all apprentices have achieved the learning outcomes identified in the curriculum standard.

It is not the intent of the in-school curriculum to perfect on-the-job skills. The practical portion of the in-school program is used to reinforce theoretical knowledge. Skill training is provided on the job.

Please refer to Skilled Trades Ontario website (www.skilledtradesontario.ca) for the most accurate and up-to-date information about Skilled Trades Ontario. For information on *Building Opportunities in the Skilled Trades Act, 2021 (BOSTA)* and its regulations, please visit [Building Opportunities in the Skilled Trades Act, 2021, S.O. 2021, c. 28 - Bill 288 \(ontario.ca\)](http://www.skilledtradesontario.ca/building-opportunities-in-the-skilled-trades-act-2021-s.o.-2021-c.-28-bill-288)

Pre-requisites

In order to advance to Level 2 of the apprenticeship program, an individual must have completed all of the units outlined in Level 1. Similarly, in order to advance to Level 3 of the program, an individual must have completed all of the units outlined in Level 1 and 2.

Hours Disclaimer (if applicable)

It is agreed that Training Delivery Agents (TDAs) may need to make slight adjustments (with cause) according to particular apprentice needs and may deviate from the unit sequencing and the prescribed practical and theoretical hours shown within the standard. However, all TDAs will comply with the hours at the reportable subject level.

Suggested Equipment for Training Delivery Agencies

Personal and Safety Equipment: Personal protective equipment is at the discretion of the TDA who must conform to Ontario Provincial Health and Safety Regulations.

Level 2

Reportable Subject Summary – Level 2

Number	Reportable Subjects	Hours Total	Hours Theory	Hours Practical
S0649	Applied Trade Calculations, Charts, Tables	30	30	0
S0650	Engineering Drawings/CAD Data	30	12	18
S0651	Metallurgy of Jig and Fixture Components	12	8	4
S0652	Metrology (Measuring and Checking)	6	4	2
S0653	Turning Technology	6	2	4
S0654	Milling Technology	12	4	8
S0655	Grinding Technology	21	6	15
S0656	Ram/Sink EDM Technology	6	6	0
S0657	Machining Centre CNC Technology	24	12	12
S0658	Tooling Technology (Jig and Fixtures)	12	7	5
S0659	Tooling Assembly Techniques for Jig and Fixtures	18	6	12
S0660	Jig and Fixture Building	63	23	40
	Total	240	120	120

Number:	S0649		
Title:	Applied Trade Calculations, Charts & Tables		
Duration:	Total Hours: 30	Theory: 30	Practical: 0
Prerequisites:	L1 CC: S0601, S0602, S0603, S0604, S0605, S0606, S0607, S0608, S0609, S0610, S0611		
Content:	S0649.1	Solve trade-specific problems involving Pythagorean Theorem and solve for unknown values. (4 hrs)	
	S0649.2	Solve trade-specific problems involving right angle triangle trigonometry and solve for unknown values. (10 hrs)	
	S0649.3	Solve trade-specific problems involving circles and solve for unknown values. (4 hrs)	
	S0649.4	Perform tooling and die trade-specific calculations. (12 hrs)	

Evaluation & Testing: Assignments related to theory and application skills
Minimum of one mid-term test during the term
Final test at end of term
Periodic quizzes

Instructional/Delivery Strategies: Lecture
Video
Paper based material
CBT
Internet On-Line

Reference Materials: Technology of Machine Tools
Shop Text Books
Basic and Advanced Tool and Die Making

Number:	S0649.0		
Title:	Applied Trade Calculations, Charts & Tables		
Duration:	Total Hours: 30	Theory: 30	Practical: 0

General Learning Outcomes

Upon successful completion the apprentice is able to apply mathematical principles to trade-specific applications.

Learning Outcomes and Content

49.1 Solve trade-specific problems involving the Pythagorean Theorem and solve for unknown values. (4 hrs)

Describe the application of the Pythagorean Theorem.

Calculate the values of unknown sides of right angle triangles using the Pythagorean Theorem.

49.2 Solve trade-specific problems involving right angle triangle trigonometry and solve for unknown values. (10 hrs)

Describe the sides of a right angle triangle with reference to each of the angles.

Describe the six trigonometric functions of right angle triangles:

- sine
- cosine
- tangent
- cotangent
- secant
- cosecant

Calculate the values of unknown sides and angles of a right angle triangle:

- values of a trigonometric function
- values of two sides
- values of one side and one angle
- ratio of sides

49.3 Solve trade-specific problems involving circles and solve for unknown values. (4 hrs)

Describe a circle and the parts of the circle:

- circumference
- chord
- diameter
- radius
- arc
- tangent
- secant
- segment
- central angle
- inscribed angle

Calculate the values of unknown parts of a circle involving:

- geometric shapes inside a circle
- geometric shapes outside a circle

49.4 Perform tool and die trade-specific calculations. (12 hrs)

Perform trade-specific calculations to determine

- tapers
- bevels
- distance between holes
- distance between v slots
- Vee-block applications
- dovetails
- draft angles
- slide angles
- cam angles
- three-wire method
- thread measurement

Evaluation Structure		
Theory Testing	Practical Application Testing	Final Assessment
100%	0%	100%

Number:	S0650		
Title:	Engineering Drawings/CAD Data		
Duration:	Total Hours: 30	Theory: 12	Practical: 18
Prerequisites:	L1 CC: S0601, S0602, S0603, S0604, S0605, S0606, S0607, S0608, S0609, S0610, S0611		
Content:	S0650.1	Describe the graphic language and symbols of engineering drawings and CAD data. (2 hrs)	
	S0650.2	Describe dimensional terminology, symbols and practices. (2 hrs)	
	S0650.3	Demonstrate sketching of revolved, removed, partial, and broken out sectional views. (9 hrs)	
	S0650.4	Identify tolerance, allowance, and symbols as applied to the dimensioned features of a workpiece. (10 hrs)	
	S0650.5	Describe elements and features of jig and fixture drawings, production drawings, and CAD data. (2 hrs)	
	S0650.6	Identify the features, elements, and types of gears, cams, and bearings. (2 hrs)	
	S0650.7	Develop an operational plan for machining jig and fixture components. (3 hrs)	

Evaluation & Testing: Assignments related to theory and application skills
Minimum of one mid-term test during the term
Final test at end of term
Periodic quizzes

Instructional/Delivery Strategies: Lecture
Video
Paper based material
CBT
Internet On-Line

Reference Materials: Shop Text Books
Interpreting Engineering Drawings
Basic and Advanced Tool and Die Making

Number:	S0650.0		
Title:	Engineering Drawings/CAD Data		
Duration:	Total Hours: 30	Theory: 12	Practical: 18

General Learning Outcomes

Upon successful completion the apprentice is able to sketch revolved, removed, partial, and broken out sectional views; identify GDT terminology; and, plan for machining jig and fixture components.

Learning Outcomes and Content

50.1 Describe the graphic language and symbols of engineering drawings and CAD data. (2 hrs)

Interpret types of graphic representations:

- detail
- views
- components
- sub-assembly
- working assembly
- assembly sequence
- location
- surface texture
- positional tolerancing
- machined surfaces
- geometric symbols
- not to scale
- machining sequence

50.2 Describe dimensional terminology, symbols, and practices. (2 hrs)

Describe dimensional terms:

- break line
- (PCD) pitch circle diameter
- (BCD) bolt circle diameter
- across flats
- pictorial
- schematic
- simplified

Describe dimensioning methods:

- point-to-point
- datum
- tabular
- arrowless

Identify thread representations and designations:

- acme
- pipe
- thread forms (ISO)
- metric
- unified
- whitworth

Identify screw thread designations for CSA, ANSI, MIL, and ISO forms:

- nominal diameter
- outside diameter (OD)
- threads per inch
- pitch
- pitch diameter
- class of fit
- external
- internal
- left
- right
- thread forms

Identify drawing elements related to workpiece processing techniques:

- welding symbols
- forging or casting draft angles
- fillets
- rounds
- non-machined dimensional features
- nominal dimensions

50.3 Demonstrate procedures for sketching revolved, removed, partial, and broken out sectional views. (9 hrs)

Identify types of sections views:

- revolved
- removed
- partial
- broken out

Identify orthographic projections:

- removed
- partial
- broken out

Describe auxiliary views of orthographic projection.

Describe the basic function of an auxiliary view:

- angular position
- inclined surface
- true shape
- profile

Describe the types of auxiliary views:

- primary
- secondary
- sectional

Describe types of sectional views:

- partial
- revolved
- removed
- offset
- broken out

Demonstrate sketching to scale section views:

- offset
- partial
- revolved
- removed
- broken out

50.4 Identify tolerance, allowance, and symbols as applied to the dimensioned features of a workpiece. (10 hrs)

Identify geometric dimensioning and tolerancing terminology:

- straightness
- flatness
- roundness (circularity)
- cylindricity
- profile of a line and a surface
- angularity
- perpendicularity
- parallelism
- position
- concentricity
- symmetry
- feature control frame
- general rules
- virtual condition
- total run-out
- maximum material condition
- regardless of feature size
- least material condition
- projected tolerance zone
- basic dimension
- datum feature and targets
- circular run-out
- correlative tolerance
- datums

50.5 Describe elements and features of jig and fixture drawings, production drawings, and CAD data. (2 hrs)

Identify details of jig and fixture drawings and production drawings for:

- jigs/fixtures
- gears
- cams
- bearings
- bushings
- gear, cam, and bearing drawings
- simplified tool drawings (production drawings)
- CAD data

Interpret features of a finished component using first or third angle projection.

50.6 Identify the features, elements, and types of gears, cams, and bearings.
(2 hrs)

Identify gear and cam symbols:

- addendum
- dedendum
- circular pitch
- diametral pitch
- clearance
- whole depth
- tooth pressure angle
- rise
- fall
- anti-friction
- angular
- sleeve
- dwell
- drop

Identify component parts of gears, cams, and bearings used in jig and fixture assembly:

- helical springs
- cams
- roller bearings
- retaining springs
- “O” rings seals
- swivel/universal joints

50.7 Develop an operational plan for machining jig and fixtures components.
(3 hrs)

Interpret drawings/CAD data to identify machining methods and procedures.

Describe ANSI, ISO & CSA standard limits and fits:

- allowance
- clearance
- interference
- tolerancing
- interchangeability
- nominal size
- designation of fits
- description of fits

Evaluation Structure		
Theory Testing	Practical Application Testing	Final Assessment
40%	60%	100%

Number:	S0651		
Title:	Metallurgy Of Jig and Fixture Components		
Duration:	Total Hours: 12	Theory: 8	Practical: 4
Prerequisites:	L1 CC: S0601, S0602, S0603, S0604, S0605, S0606, S0607, S0608, S0609, S0610, S0611		
Content:	S0651.1	Describe safe working procedures associated with heat-treating furnaces and hand held equipment.	
	S0651.2	Describe ferrous metal heat-treating processes. (5 hrs)	
	S0651.3	Describe hardness testing methods. (5 hrs)	
	S0651.4	Describe elements and machinability of non-ferrous metals. (2 hrs)	

Evaluation & Testing: Assignments related to theory and application skills
Minimum of one mid-term test during the term
Final test at end of term
Periodic quizzes

Instructional/Delivery Strategies: Lecture
Video
Paper based material
CBT
Internet On-Line

Reference Materials: Shop Text Books
Jig & Fixture Making for Metal Working
Basic and Advanced Tool and Die Making

Number:	S0651.0		
Title:	Metallurgy of Jig and Fixture Components		
Duration:	Total Hours: 12	Theory: 8	Practical: 4

General Learning Outcomes

Upon successful completion the apprentice is able to describe the heat-treating and testing of ferrous and non-ferrous metals.

Learning Outcomes and Content

- 51.1 Describe safe working procedures associated with heat-treating furnaces and hand held equipment.
- Identify potential safety hazards which may occur during the setting up and operating of heat-treating procedures.
- Identify heat-treating safe working habits and protective equipment including:
- asbestos gloves
 - asbestos aprons
 - arm shields
 - face shields
 - checking workpieces
 - toxic fumes
 - good housekeeping
 - temperatures
 - ventilation
 - securing workpiece
 - stabilizing workpiece
 - fire hazards
- 51.2 Describe ferrous metal heat-treating processes. (5 hrs)
- Describe flame hardening and tempering processes:
- tempering colours
 - quenching media
 - surface preparation
 - workpiece holding/positioning

Describe the process and advantages for hardening of ferrous metals:

- heat-treating specifications
- quenching media
- metallurgical structural change
- hardness obtainable
- strength
- toughness
- wear resistance
- machinability
- distortion
- work preparation procedures
- time-temperature cycle
- depth of hardness
- quenching procedures
- pre-heating
- cooling

Describe the process and advantages for pack and gas carburizing of steel:

- heat-treating specifications
- carbon content
- hardenability
- strength
- toughness
- wear resistance
- machinability
- type of furnace
- carbonaceous mixtures
- work preparation procedures
- depth of case
- selective areas to be carburized
- time-temperature cycle

Describe the process and advantages for tempering of ferrous metals:

- heat-treating specifications
- metallurgical structural change
- hardness
- strength
- toughness
- wear resistance
- machinability
- time-temperature cycle
- tempering colours

Describe the process and advantages for annealing of ferrous metals:

- heat-treating specifications
- internal stresses
- machinability
- type of furnace
- cooling procedures

Describe the process and advantages for normalizing of ferrous metals:

- heat-treating specifications
- internal stresses
- grain refinement
- machinability
- cooling procedures

51.3 Describe hardness-testing methods. (5 hrs)

Describe hardness testing methods and procedures.

Describe types and operating principles of hardness testers:

- Rockwell
- Brinell
- Vickers
- Scleroscope
- Spark

Describe the range and values of hardness tester scales.

Describe the types of equipment for hardness testers:

- penetrators
- anvils
- loads

51.4 Describe elements and machinability of non-ferrous metals. (2 hrs)

Describe the characteristics of non-ferrous metals:

- smelting and shaping process
- shapes
- sizes
- tolerances
- surface conditions
- UNS/SAE/ASTM code classifications
- manufacturer=s code classifications
- applications
- properties
 - chemical
 - physical
 - mechanical
- alloying elements
- tensile strength
- malleability
- ductility
- machinability
- castability
- weight comparison
- hardness
- corrosion resistance
- wear resistance
- colour
- melting point

Evaluation Structure		
Theory Testing	Practical Application Testing	Final Assessment
60%	40%	100%

Number:	S0652		
Title:	Metrology (Measuring and Checking)		
Duration:	Total Hours: 6	Theory: 4	Practical: 2
Prerequisites:	L1 CC: S0601, S0602, S0603, S0604, S0605, S0606, S0607, S0608, S0609, S0610, S0611		
Content:	S0652.1	Identify the fundamentals of dimensional metrology. (0.5 hrs)	
	S0652.2	Describe the fundamentals of measuring, checking, and gauging equipment. (0.5 hrs)	
	S0652.3	Demonstrate measuring techniques using direct/indirect reading linear measuring equipment. (1 hr)	
	S0652.4	Describe measuring and checking procedures using inspection and checking gauges. (2 hrs)	
	S0652.5	Describe measuring and checking procedures using indicating gauges and comparators. (1 hr)	
	S0652.6	Describe surface roughness measurement procedures. (1 hr)	

Evaluation & Testing: Assignments related to theory and application skills
Minimum of one mid-term test during the term
Final test at end of term
Periodic quizzes

Instructional/Delivery Strategies: Lecture
Video
Paper based material
CBT
Internet On-Line

Reference Materials: Technology of Machine Tools
Shop Text Books
Jig & Fixture Making for Metal Working
Basic and Advanced Tool and Die Making

Number:	S0652.0		
Title:	Metrology (Measuring and Checking)		
Duration:	Total Hours: 6	Theory: 4	Practical: 2

General Learning Outcomes

Upon successful completion the apprentice is able to describe use of direct/indirect reading linear measuring equipment, inspection gauges, indicating gauges and comparators; describe surface roughness measurement procedures.

Learning Outcomes and Content

52.1 Identify the fundamentals of dimensional metrology. (0.5 hrs)

Describe the fundamentals of dimensional metrology:

- accuracy
- precision
- tolerances
- reliability
- limits
- fits
- datums
- discrimination
- lengths/widths
- angular
- straight
- flat
- square
- round
- surface texture
- perpendicularity
- parallel

52.2 Describe the fundamentals of measuring, checking, and gauging equipment. (0.5 hrs)

Describe direct reading linear measuring equipment:

- interchangeable anvil micrometer
- bench micrometer
- thread micrometer
- indicating micrometer
- deep throat micrometer
- V-anvil micrometer
- disc micrometer
- blade micrometer
- tube micrometer
- wire micrometer
- gear tooth vernier caliper

Describe indirect reading angular equipment:

- sine plate
- tool maker's square
- precision level

Describe inspection and checking gauges:

- plug gauges
- ring gauges
- snap gauges
- profilometer
- precision rollers
- precision balls
- thread wires
- gear tooth rollers

Describe indicating gauges and comparators:

- optical comparators
- mechanical/electrical comparators
- air gauges
- optical flats

Describe fundamentals and features of coordinate measuring machines (CMM).

- 52.3 Describe measuring techniques using direct/indirect reading linear measuring equipment. (1 hr)
- Demonstrate measuring techniques using direct reading linear measuring equipment.
- Demonstrate measuring techniques using indirect reading angular equipment.
- Describe measuring techniques using inspection and checking gauges.
- Describe measuring techniques using indicating gauges.
- 52.4 Describe measuring and checking procedures using inspection and checking gauges. (2 hrs)
- Describe cleaning techniques of calibrated test specimen surfaces.
- Select inspection and checking gauges to check:
- gear forms
 - profiles
 - pitch diameters
 - gear parts
 - gear teeth
 - angles
 - surface finishes
 - surface roughness
 - dimensions
 - contours
- Demonstrate inspection and recording techniques.
- Identify error sources in measurement techniques:
- inherent instrument error
 - observational error
 - manipulative error
 - bias error
 - parallel error

52.5 Describe measuring and checking procedures using indicating gauges and comparators. (1 hr)

Describe cleaning techniques of calibrated test specimen surfaces.

Describe features to be checked.

Describe measuring techniques using indicating gauges and comparators:

- optical comparators
- mechanical comparators
- air gauges
- optical flats

Demonstrate inspection and recording techniques.

52.6 Describe surface roughness measurement procedures. (1 hr)

Describe cleaning techniques of calibrated test specimen surface.

Describe surface roughness range.

Identify surface roughness measuring equipment:

- profilometer
- surface texture gauge

Evaluation Structure		
Theory Testing	Practical Application Testing	Final Assessment
60%	40%	100%

Number:	S0653		
Title:	Turning Technology		
Duration:	Total Hours: 6	Theory: 2	Practical: 4
Prerequisites:	L1 CC: S0601, S0602, S0603, S0604, S0605, S0606, S0607, S0608, S0609, S0610, S0611		
Content:	S0653.1	Describe safe working procedures when setting up and operating a lathe.	
	S0653.2	Set up lathe workholding devices, attachments, and accessories. (0.5 hrs)	
	S0653.3	Set up lathe thread and/or form cutting tools and tool holders. (0.5 hrs)	
	S0653.4	Demonstrate turning techniques to produce jig and fixture components. (5 hrs)	

Evaluation & Testing: Assignments related to theory and application skills
Minimum of one mid-term test during the term
Final test at end of term
Periodic quizzes

Instructional/Delivery Strategies: Lecture
Video
Paper based material
CBT
Internet On-Line

Reference Materials: Technology of Machine Tools
Shop Text Books
Jig & Fixture Making for Metal Working
Basic and Advanced Tool and Die Making

Number:	S0653.0		
Title:	Turning Technology		
Duration:	Total Hours: 6	Theory: 2	Practical: 4

General Learning Outcomes

Upon successful completion the apprentice is able to perform turning techniques to produce jig and fixture components.

Learning Outcomes and Content

53.1 Describe safe working procedures when setting up and operating a lathe.

Identify potential safety hazards which may occur during the setting up and operating lathe.

Demonstrate safe working habits including:

- protective clothing
- protective equipment and gear
- good housekeeping
- start-up
- shut-off
- securing workpiece/cutting tools
- stabilizing workpiece/cutting tools
- lubricants
- lock-out procedures
- tagging procedures

53.2 Set up lathe workholding devices, attachments, and accessories. (0.5 hrs)

Identify lathe workholding devices, attachments, and accessories:

- taper attachment
- tracing attachment
- radius attachment
- tool post grinder

Perform contact surface cleaning procedures.

53.3 Set up lathe thread and/or form cutting tools and tool holders. (0.5 hrs)

Identify thread and tool geometry for lathe cutting tools.

Describe lathe thread and/or cutting tools:

- right
- left
- internal
- external
- form tools

Demonstrate mounting, positioning, alignment, and securing procedures for form cutting tools and tool holders.

53.4 Perform turning techniques to produce jig and fixture components. (5 hrs)

Describe types of internal internal and external tapers and angles:

- Jarno
- Morse
- Brown and Sharp

Describe set-up procedures to produce an internal and external taper using:

- tailstock offset
- compound rest
- taper turning attachments

Describe methods of rough and finish turning.

Describe methods of turning contoured surfaces:

- external
- internal
- concave
- convex
- irregular

Describe the finish allowance required by determining:

- finish tolerance
- surface finish

Demonstrate turning of internal and external tapers and angles.

Demonstrate turning of contours.

Evaluation Structure		
Theory Testing	Practical Application Testing	Final Assessment
20%	80%	100%

Number:	S0654		
Title:	Milling Technology		
Duration:	Total Hours: 12	Theory: 4	Practical: 8
Prerequisites:	L1 CC: S0601, S0602, S0603, S0604, S0605, S0606, S0607, S0608, S0609, S0610, S0611		
Content:	S0654.1	Describe safe working procedures when setting up and operating milling machines.	
	S0654.2	Identify milling attachments to machine jig and fixture components. (2 hrs)	
	S0654.3	Demonstrate set-up procedures for horizontal or vertical mill workholding devices and accessories. (1 hr)	
	S0654.4	Demonstrate the assembly of cutting tools and tool holders. (2 hrs)	
	S0654.5	Develop a plan for milling and boring. (1 hr)	
	S0654.6	Perform milling and boring. (6 hrs)	

Evaluation & Testing: Assignments related to theory and application skills
Minimum of one mid-term test during the term
Final test at end of term
Periodic quizzes

Instructional/Delivery Strategies: Lecture
Video
Paper based material
CBT
Internet On-Line

Reference Materials: Technology of Machine Tools
Shop Text Books
Jig & Fixture Making for Metal Working
Basic and Advanced Tool and Die Making

Number:	S0654.0		
Title:	Milling Technology		
Duration:	Total Hours: 12	Theory: 4	Practical: 8

General Learning Outcomes

Upon successful completion the apprentice is able to mill and bore jig and fixture components.

Learning Outcomes and Content

54.1 Describe safe working procedures when setting up and operating milling machines.

Identify potential safety hazards which may occur during the setting up and operation of mills.

Demonstrate safe working habits including:

- protective clothing
- protective equipment and gear
- good housekeeping
- start-up
- shut-off
- securing workpiece/cutting tool
- stabilizing workpiece/cutting tool
- lock-out procedures
- tagging procedures

54.2 Identify milling attachments used to machine jig and fixture components. (2 hrs)

Identify milling attachments:

- slotting head
- horizontal attachment
- vertical attachment
- rack milling attachment
- digital read-out

54.3 Demonstrate set up procedures for horizontal or vertical milling workholding devices and accessories. (1 hr)

Describe horizontal or vertical milling workholding devices and accessories:

- dividing head
- rotary table

Demonstrate set up procedures.

Demonstrate contact surface cleaning procedures.

54.4 Demonstrate the assembly of cutting tools and tool holders. (2 hrs)

Identify cutting tool geometry (nomenclature).

Describe cutting tools and tool holders:

- plain-milling
- angular milling
- form-milling
- slitting saws
- key seat milling
- T-slot milling
- dovetail milling
- adaptors

Demonstrate cutting tool and tool holder assembly.

54.5 Develop a plan for milling and boring. (1 hr)

Select milling procedures to mill types of surfaces:

- horizontal
- vertical
- angular
- contoured (form)

Select milling procedures to bore holes.

Select milling procedures to produce slots.

Select milling workholding devices.

Select cutting tools and tool holding devices and accessories.

54.6 Perform milling and boring. (6 hrs)

Describe index milling using a dividing head.

Describe index milling using a rotary table.

Demonstrate milling horizontal, vertical, angular, and contoured surfaces.

Demonstrate boring of holes.

Evaluation Structure		
Theory Testing	Practical Application Testing	Final Assessment
30%	70%	100%

Number:	S0655		
Title:	Grinding Technology		
Duration:	Total Hours: 21	Theory: 6	Practical: 15
Prerequisites:	L1 CC: S0601, S0602, S0603, S0604, S0605, S0606, S0607, S0608, S0609, S0610, S0611		
Content:	S0655.1	Describe safe working procedures when setting up and operating grinders.	
	S0655.2	Select surface or cylindrical grinder controls and coolant. (1 hr)	
	S0655.3	Set up surface or cylindrical grinder workholding devices, accessories, and attachments. (1 hr)	
	S0655.4	Demonstrate mounting, truing and dressing of grinding wheels. (1 hr)	
	S0655.5	Develop a plan for grinding flat surfaces, tapers, angles, and profiles. (2 hrs)	
	S0655.6	Perform grinding. (13 hrs)	

Evaluation & Testing: Assignments related to theory and application skills
Minimum of one mid-term test during the term
Final test at end of term
Periodic quizzes

Instructional/Delivery Strategies: Lecture
Video
Paper based material
CBT
Internet On-Line

Reference Materials: Technology of Machine Tools
Shop Text Books
Jig & Fixture Making for Metal Working
Basic and Advanced Tool and Die Making

Number:	S0655.0		
Title:	Grinding Technology		
Duration:	Total Hours: 21	Theory: 6	Practical: 15

General Learning Outcomes

Upon successful completion the apprentice is able to grind jig and fixture components.

Learning Outcomes and Content

55.1 Describe safe working procedures when setting up and operating grinders.

Identify potential safety hazards which may occur during grinder set-up and operational procedures.

Demonstrate safe working habits including:

- protective clothing and gear
- good housekeeping
- start-up
- shut-off
- securing workpiece
- stabilizing workpiece
- guards
- dust extraction system
- dressing wheel
- inspecting wheel
- ringing of wheel
- maximum wheel rpm
- lock-out procedures
- tagging procedures

55.2 Select surface or cylindrical grinder controls and coolant. (1 hr)

Describe functions and operating principles of cylindrical grinder.

Identify parts of cylindrical grinder:

- in-feed control
- table
- bedways
- base
- wheelhead
- table traverse mechanism
- trip dogs
- saddle
- footstock
- swivel table adjustment
- work head

Identify surface or cylindrical controls:

- main switch
- stop-start switch
- table traverse
- in-feed selection
- cross-feed
- wheel feed
- cutting fluid
- table dwell
- workhead speed
- feeds

Describe cutting fluids:

- soluble oils
- synthetics
- semi-synthetics

55.3 Set up surface or cylindrical grinder workholding devices, accessories, and attachments. (1 hr)

Describe grinder workholding devices, accessories, and attachments:

- diamond dressing attachment
- magnetic chuck
- laminated blocks
- fixtures
- angular wheel dresser
- radius dresser
- collet chuck
- centres
- adhesives
- demagnetizer

Select workholding devices, accessories, and attachments by determining:

- type
- size
- function
- holding/mounting characteristics
- type of wheel
- workpiece characteristics
- handling, storing, and maintenance

Demonstrate contact surface cleaning procedures.

Demonstrate magnetizing procedures for permanent or electromagnetic chucks.

Demonstrate mounting, positioning, aligning, and securing procedures.

Demonstrate procedures for demagnetizing the workpiece.

55.4 Demonstrate mounting, truing, and dressing of grinding wheels. (1 hr)

Demonstrate mounting, truing, balancing, and dressing of wheel.

Describe balancing of wheel.

Describe safe mounting of wheels on surface or cylindrical grinders.

Demonstrate dressing for side grinding or form grinding.

Demonstrate use of radius tangent wheel dresser.

55.5 Develop a plan for grinding flat surfaces, tapers, angles, and profiles. (2 hrs)

Select grinding procedures:

- surface
- plunge
- cut off
- inside diameter (ID)/outside diameter (OD)
- profile
- parallel/traverse
- external taper

Identify grinder workholding devices and accessories.

Select required surface or cylindrical grinder.

Describe measuring and checking techniques.

55.6 Perform grinding. (13 hrs)

Describe profile grinding.

Describe plunge grinding.

Describe angular grinding.

Describe combination angle and radius grinding.

Demonstrate OD grinding.

Demonstrate ID grinding.

Demonstrate taper O/D grinding.

Evaluation Structure		
Theory Testing	Practical Application Testing	Final Assessment
30%	70%	100%

Number:	S0656		
Title:	Ram/Sink Electrical Discharge Machining (EDM) Technology		
Duration:	Total Hours: 6	Theory: 6	Practical: 0
Prerequisites:	L1 CC: S0601, S0602, S0603, S0604, S0605, S0606, S0607, S0608, S0609, S0610, S0611		
Content:	S0656.1	Describe safety procedures when setting up and operating EDM machines.	
	S0656.2	Describe machine controls, dielectric fluid requirements, and settings of ram/sink type EDM machines. (1 hr)	
	S0656.3	Describe assembly of EDM electrodes and holders. (1 hr)	
	S0656.4	Select ram/sink EDM techniques to spark erode jig and fixture components. (3 hrs)	
	S0656.5	Describe routine maintenance. (1 hr)	

Evaluation & Testing: Assignments related to theory and application skills
Minimum of one mid-term test during the term
Final test at end of term
Periodic quizzes

Instructional/Delivery Strategies: Lecture
Video
Paper based material
CBT
Internet On-Line

Reference Materials: Technology of Machine Tools
Shop Text Books
Jig & Fixture Making for Metal Working
Basic and Advanced Tool and Die Making

Number:	S0656.0		
Title:	Ram/Sink Electrical Discharge Machining (EDM) Technology		
Duration:	Total Hours: 6	Theory: 6	Practical: 0

General Learning Outcomes

Upon successful completion the apprentice is able to describe ram/sink EDM procedures for producing jig and fixture components.

Learning Outcomes and Content

56.1 Describe safe working procedures when setting up and operating EDM machines.

Identify potential safety hazards which may occur during the setting up and operation of EDM machines.

Demonstrate safe working habits including:

- protective clothing
- protective equipment and gear
- good housekeeping
- securing workpiece
- stabilizing workpiece
- start-up
- shut-down
- dielectric fluids
- excessive heat
- lock out procedures
- tagging procedures

56.2 Describe machine controls, dielectric fluid requirements, and settings of ram/sink type EDM machines. (1 hr)

Identify machine controls, dielectric fluid, and operating principles of the EDM by determining:

- application
- type
- workholding devices
- dielectric fluid
- polarity
- table travel
- resistance capacity
- pulse type
- rotary impulse
- table axis movements

Describe feed control values and the graduations of micrometer collars.

56.3 Describe the assembly of EDM electrodes and holders. (1 hr)

Describe the machining characteristics of electrode materials:

- brass
- copper
- silver tungsten grades
- graphite
- premium graphite

Identify machining or manual methods to produce electrodes by using:

- part product prints
- charts
- templates

Identify the electrode overburn allowances by determining:

- electrode material
- workpiece material
- removal rate

Describe flushing techniques.

Describe holding requirements.

Calculate the wear ratio of the electrode materials.

Determine required number of electrodes.

56.4 Select ram/sink EDM techniques to spark erode jig and fixture components. (3 hrs)

Describe machining sequence to spark erode component.

Identify the number of electrodes to be used by determining:

- amount of material to be removed
- electrode material
- workpiece material
- surface finish
- degree of accuracy
- flushing conditions

Describe overburn.

Describe EDM cutting arc conditions:

- shorted arc
- D/C arc
- open arc
- erratic cutting
- transistor failure
- excessive heat in power supply

Describe ram/sink EDM machining procedures to produce a jig and fixture component:

- flat
- contours
- angles
- slots
- holes
- helical shapes
- peripheries

56.5 Describe routine maintenance. (1 hr)

Describe lubrication and cleaning procedures.

Describe dismantling, handling, and storage of tools, tooling, workholding devices, and measuring instruments.

Evaluation Structure		
Theory Testing	Practical Application Testing	Final Assessment
100%	0%	100%

Number:	S0657		
Title:	Machining Centre Computerized Numerical Control (CNC) Technology		
Duration:	Total Hours: 24	Theory: 12	Practical: 12
Prerequisites:	L1 CC: S0601, S0602, S0603, S0604, S0605, S0606, S0607, S0608, S0609, S0610, S0611		
Content:	S0657.1	Describe safe working procedures when setting up and operating CNC machining centres.	
	S0657.2	Describe operating principles and applications of CNC machining centres. (1 hr)	
	S0657.3	Describe the basics of CNC dimensioning. (2 hrs)	
	S0657.4	Describe part programming methods, set-up sheets, tooling lists, part program manuscripts, and input media. (4 hrs)	
	S0657.5	Describe manual operation systems for CNC machining centres. (2 hrs)	
	S0657.6	Develop a plan for a CNC machining centre. (2 hrs)	
	S0657.7	Demonstrate procedures for entering and verifying a program for a CNC machining centre to perform linear and circular machining exercises. (13 hrs)	

Evaluation & Testing: Assignments related to theory and application skills
Minimum of one mid-term test during the term
Final test at end of term
Periodic quizzes

Instructional/Delivery Strategies: Lecture
Video
Paper based material
CBT
Internet On-Line

Reference Materials: Technology of Machine Tools
Shop Text Books
Jig & Fixture Making for Metal Working
Basic and Advanced Tool and Die Making

Number:	S0657.0		
Title:	Machining Centre Computerized Numerical Control (CNC) Technology		
Duration:	Total Hours: 24	Theory: 12	Practical: 12

General Learning Outcomes

Upon successful completion the apprentice is able to read and interpret CNC documentation; and demonstrate procedures for entering and verifying a CNC program for drilling, linear interpolation, and circular interpolation.

Learning Outcomes and Content

57.1 Describe safe working procedures when setting up and operating CNC machining centres.

Identify potential safety hazards which may occur during the setting up and operating of CNC machining centres.

Demonstrate safe working habits including:

- protective clothing
- protective equipment and gear
- good housekeeping
- operating procedures
- start-up
- shut-off
- securing workpiece/machine-tools
- stabilizing workpiece/machine-tools
- lubricants
- lock-out procedures
- tagging procedures

57.2 Describe operating principles and applications of CNC machining centres. (1 hr)

Identify types of CNC machining centres:

- vertical
- horizontal
- multi-axis

Describe the capabilities of CNC machining systems:

- types of equipment
- editing capability
- program path ability
- processing power
- high speed machining

Identify the operating principles and applications of CNC machining centre controls:

- CNC controls
- tapeless control
- PC/DNC systems
- conversational programming

Describe the major features and functions of machining centres:

- CPU
- input devices
- tool changer
- work envelope
- holding devices
- safety interlocks
- engineering drawing
- CNC part program
- input media
- CNC machine tool
- finished part
- repeatability

Describe the common means of producing part program files:

- manual programming
- CAM systems
- conversational programming

57.3 Describe the basics of CNC dimensioning. (2 hrs)

Describe the Cartesian Coordinate System:

- quadrant notation
- point location in XY plane
- point location in XYZ plane

Describe machine tool axis designations:

- primary linear axis
- secondary linear axis
- primary rotary axis
- secondary rotary axis
- right hand rule
- axis orientation

Describe machine zero point locations:

- fixed zero points
- full zero shift
- floating zero

Determine set-up point locations to establish:

- machine home position
- absolute zero position
- Z axis touch off points

Describe CNC machining centre capabilities of positioning and contouring:

- linear interpolation
- circular interpolation

Describe use of dimensioning practices:

- baseline dimensioning (datum)
- relative (chain) dimensioning

Select coordinate systems for CNC machining centres:

- type of machine
- axis designation
- typical specifications

57.4 Describe part programming methods, set-up sheets, tooling lists, part program manuscripts, and input media. (4 hrs)

Identify documentation used for the CNC machining process:

- set-up sheet
- tooling list
- part program manuscript
- input media

Describe the individual components of a part program manuscript:

- sequence numbers
- preparatory functions
- miscellaneous functions
- axis motions
- feed rates
- spindle speeds
- tool numbers

Describe additional word and block structures that exist within the part program code:

- decimal point programming
- block delete
- comments

Describe the components of a set-up sheet:

- part zero position
- part location
- clamp
- fixture locations

Describe the components of a tooling list:

- tool type
- tool number
- diameter offset number
- tool length offset number

Describe the methods of producing part program files:

- CAM systems
- manual programming
- conversational programming

57.5 Describe manual operation systems for CNC machining centres. (2 hrs)

Describe manual program interruption:

- single block operation
- feedhold
- emergency stop

Describe manual data input (MDI):

- line command execution
- set-up applications

Describe program data override:

- rapid motion override
- spindle speed override
- feedrate override
- dry run operation
- manual absolute setting
- practical applications

Describe interfacing to peripherals:

- RS-232C Interface
- PC/DNC
- USB
- wireless

57.6 Develop a plan for a CNC machining centre. (2 hrs)

Interpret documentation to determine:

- workpiece material specifications
- method of routing instructions
- special fixturing requirements

Plan sequence of machining by identifying:

- order of machining
- tooling selection
- workpiece set-up

57.7 Demonstrate procedures for entering and verifying a program for a CNC machining centre to perform linear and circular machining exercises. (13 hrs)

Demonstrate the use of preparatory commands (G-codes):

- modality of G-codes
- recognize conflicting commands
- order in a block

Demonstrate the use of M-codes:

- typical M-codes
- M-codes in a block

Demonstrate the use of codes to specify dimensions:

- metric/inch selection
- absolute data input - G90
- incremental input - G91
- combination in the same program
- radius programming

Demonstrate the use of codes to specify speeds and feeds:

- spindle rotation direction
- spindle stop
- spindle orientation
- spindle speed (RPM)
- feedrate function
- feedrate control
- feedrate per minute
- feedrate override and feedhold
- feedrate override and functions

Demonstrate the use of codes to specify:

- tool number
- tool length offset
- tool radius offset.

Demonstrate the use of codes to establish reference points:

- machine reference point
- manufacturers' setting
- workpiece reference point
- tool reference point
- position register command-G54
- fixture offsets

Demonstrate the use of common machine function controls:

- mode selector
- rapid, feedrate, and spindle overrides
- single block
- manual feed functions
- soft keys
- offset registers

Demonstrate the use of codes to produce a part.

Evaluation Structure		
Theory Testing	Practical Application Testing	Final Assessment
50%	50%	100%

Number:	S0658		
Title:	Tooling Technology (Jigs and Fixtures)		
Duration:	Total Hours: 12	Theory: 7	Practical: 5
Prerequisites:	L1 CC: S0601, S0602, S0603, S0604, S0605, S0606, S0607, S0608, S0609, S0610, S0611		
Content:	S0658.1	Describe rationale for using jigs and fixtures when manufacturing components. (1 hr)	
	S0658.2	Describe types and classifications of jigs. (2 hrs)	
	S0658.3	Describe types and classifications of fixtures. (2 hrs)	
	S0658.4	Describe jig and fixture tooling. (3 hrs)	
	S0658.5	Describe jig and fixture design characteristics. (4 hrs)	

Evaluation & Testing: Assignments related to theory and application skills
Minimum of one mid-term test during the term
Final test at end of term
Periodic quizzes

Instructional/Delivery Strategies: Lecture
Video
Paper based material
CBT
Internet On-Line

Reference Materials: Technology of Machine Tools
Shop Text Books
Jig & Fixture Making for Metal Working
Basic and Advanced Tool and Die Making

Number:	S0658.0		
Title:	Tooling Technology (Jigs and Fixtures)		
Duration:	Total Hours: 12	Theory: 7	Practical: 5

General Learning Outcomes

Upon successful completion the apprentice is able to describe jig types and classification, fixture types and classification, and operational principles and design characteristics of jigs and fixtures.

Learning Outcomes and Content

- 58.1 Describe rationale for using jigs and fixtures when manufacturing components. (1 hr)
- Describe the rationale for using jigs and fixtures when manufacturing components:
- advantages
 - disadvantages
- 58.2 Describe types and classifications of jigs. (2 hrs)
- Identify types of jigs:
- template
 - plate
 - sandwich
 - channel
 - closed (box, leaf, tumble)
 - angle plate
 - indexing
- Describe jig classifications:
- drilling
 - boring

58.3 Describe types and classifications of fixtures. (2 hrs)

Identify types of fixtures:

- plate
- angle plate
- vise jaw
- indexing
- assembly

Describe fixture classifications:

- milling
- turning
- boring
- grinding
- welding
- inspection

58.4 Describe jig and fixture tooling. (3 hrs)

Describe jig and fixture tooling components:

- tooling bodies
- bushings
- stop blocks
- locators
- supports
- clamping devices
- ejectors
- arbors
- mandrels
- vises
- magnetic chucks
- keys
- fasteners
- springs
- pads
- feet
- plugs
- pins

58.5 Describe jig and fixture design characteristics. (4 hrs)

Describe jig and fixture characteristics:

- planes
- reference surfaces and points
- workpiece location
- locators
 - fixed
 - adjustable
- supports
 - fixed
 - adjustable
- clamps
 - strap
 - screw
 - cam
 - toggle
 - wedge

Evaluation Structure		
Theory Testing	Practical Application Testing	Final Assessment
55%	45%	100%

Number:	S0659		
Title:	Tooling Assembly Technology for Jigs & Fixtures		
Duration:	Total Hours: 18	Theory: 6	Practical: 12
Prerequisites:	L1 CC: S0601, S0602, S0603, S0604, S0605, S0606, S0607, S0608, S0609, S0610, S0611		
Content:	S0659.1	Describe safe working habits when assembling tooling components.	
	S0659.2	Identify set-up equipment and attachments used for fitting, positioning, and aligning tooling components. (3 hrs)	
	S0659.3	Describe the assembly of keyed components. (4 hrs)	
	S0659.4	Describe the assembly of dowelled components. (5 hrs)	
	S0659.5	Describe final assembly processes and techniques. (6 hrs)	

Evaluation & Testing: Assignments related to theory and application skills
Minimum of one mid-term test during the term
Final test at end of term
Periodic quizzes

Instructional/Delivery Strategies: Lecture
Video
Paper based material
CBT
Internet On-Line

Reference Materials: Technology of Machine Tools
Shop Text Books
Jig & Fixture Making for Metal Working
Basic and Advanced Tool and Die Making

Number:	S0659.0		
Title:	Tooling Assembly Technology for Jigs & Fixtures		
Duration:	Total Hours: 18	Theory: 6	Practical: 12

General Learning Outcomes

Upon successful completion the apprentice is able to describe fitting and assembly techniques and plan the assembly of tooling components.

Learning Outcomes and Content

59.1 Describe safe working habits when assembling tooling components.

Identify potential safety hazards which may occur during tooling assembly procedures.

Demonstrate safe working habits including:

- protective clothing
- protective equipment and gear
- good housekeeping
- start-up
- shut-down
- securing workpiece/cutting tool
- stabilizing workpiece/cutting tool
- lubricants
- hand and power tools
- material handling equipment

59.2 Identify set-up equipment and attachments used for fitting, positioning, and aligning tooling components. (3 hrs)

Describe the application of equipment and attachments used for fitting, positioning, and aligning components:

- lathes
- mills
- grinders
- hones
- jig borers
- jig grinders
- mandrels

- vises
- angle plates
- sine bars
- grinding chucks
- files
- reamers
- stones

59.3 Describe the assembly of keyed components. (4 hrs)

Describe the operating principles and design parameters for using keys in assemblies.

Describe the required keyed assemblies by identifying:

- application
- design characteristics
- components
- types
- sizes
- fasteners
- clearances
- tolerances

Describe the keyed assembly process by determining:

- types of tools and equipment
- sizes of tools and equipment
- locations of components
- relative positions of components
- sequence of assembly
- lubricants
- key fits
- workholding requirements
- measuring and checking equipment

Identify the types of keyed component assemblies:

- plain taper
- gib head taper
- square
- rectangular
- feathered
- woodruff

59.4 Describe the assembly of dowelled components. (5 hrs)

Describe the operating principles and design parameters of dowelling assemblies.

Describe the required dowel assemblies by identifying:

- application
- design characteristics
- components
- types
- sizes
- fits

Describe the dowelled assembly process by determining:

- types and sizes of tools and/or equipment
- locations and relative positions of components
- number of dowel pins
- sequence of assembly
- use of lubricants
- dowel fits
- workholding requirements

Identify the type of pins used in assemblies:

- dowelled
- roll pin
- tapered
- groove

59.5 Describe final assembly processes and techniques. (6 hrs)

Describe types of fit:

- running
- sliding
- locational
- interference
- clearance

Describe the operating principles and design parameters of fits used in the assembly process.

Describe the type of fit by identifying:

- applications
- design characteristics
- clearances
- tolerances
- sizes
- allowances
- surface finish

Describe the assembly process by determining:

- types and sizes of tools/equipment
- locations and relative positions of components
- sequence of assembly
- use of lubricants
- pressing and guiding requirements
- heating or freezing media
- workholding requirements Describe the assembly of components.

Evaluation Structure		
Theory Testing	Practical Application Testing	Final Assessment
30%	70%	100%

Number:	S0660		
Title:	Jig And Fixture Building		
Duration:	Total Hours: 63	Theory: 23	Practical: 40
Prerequisites:	L1 CC: S0601, S0602, S0603, S0604, S0605, S0606, S0607, S0608, S0609, S0610, S0611		
Content:	S0660.1	Interpret engineering, CAD data, part drawings, component prints, assembly, jig, and fixture prints. (3 hrs)	
	S0660.2	Interpret documentation. (2 hrs)	
	S0660.3	Demonstrate detailed sketching of a component from engineering drawings and CAD data. (6 hrs)	
	S0660.4	Identify jig and fixture materials. (2 hrs)	
	S0660.5	Develop a plan for the jig and fixture building process. (4 hrs)	
	S0660.6	Demonstrate the machining, fitting, and assembling of jig and fixture components. (25 hrs)	
	S0660.7	Demonstrate jig and fixture assembly procedures. (24 hrs)	

Evaluation & Testing: Assignments related to theory and application skills
Minimum of one mid-term test during the term
Final test at end of term
Periodic quizzes

Instructional/Delivery Strategies: Lecture
Video
Paper based material
CBT
Internet On-Line

Reference Materials: Shop Text Books
Jig & Fixture Making for Metal Working
Basic and Advanced Tool and Die Making

Number:	S0660.0		
Title:	Jig and Fixture Building		
Duration:	Total Hours: 63	Theory: 23	Practical: 40

General Learning Outcomes

Upon successful completion the apprentice is able to demonstrate jig and fixture component building; and perform fitting and assembly techniques.

Learning Outcomes and Content

60.1 Interpret engineering and part drawings, CAD data, component prints, assembly, jig, and fixture prints. (3 hrs)

Interpret engineering drawings and CAD data to determine tooling construction procedures.

Interpret part prints to identify dimensional sizes, tolerances, limits, finish condition, and material type.

Identify jig and fixture component features with engineering drawings and CAD data:

- tool bodies
- bushings
- pins
- clamps
- fasteners
- keys
- springs
- locators

60.2 Interpret documentation. (2 hrs)

Interpret elements and features of engineering drawings and CAD data to determine:

- clearances
- slide travel
- size
- dimensions
- tolerances
- finishes
- assembly

Interpret tables and charts to determine clearances, shapes, and dimensions.

Interpret job specifications to determine the required clearances, fits, tolerances, and assembly methods.

60.3 Demonstrate detailed sketching of a component from engineering drawing and CAD data. (6 hrs)

Develop sketches from piece-part specification for jig and fixture component details which includes:

- shape
- dimensions
- tolerances
- finishes

60.4 Identify jig and fixture materials. (2 hrs)

Interpret engineering drawings and CAD data to identify materials by determining:

- type
- grade
- dimensions
- surface condition
- hardenability
- heat-treatment

60.5 Develop a plan for the jig and fixture building process. (4 hrs)

Develop a jig and fixture build plan that identifies:

- machine tools
- machining procedures
- machining processes
- machine accessories
- tooling aids
- jig and fixture building sequence
- fitting and assembly procedures
- fabrication processes

60.6 Demonstrate the machining, fitting, and assembling of jig and fixture components. (25 hrs)

Identify machining methods and attachments to be used in the fabrication of jig and fixture components:

- turning
- milling
- surface grinding
- cylindrical grinding
- jig boring
- jig grinding

Select workholding devices:

- grinding mandrel
- precision vises
- angle plates
- sine bars
- grinding chucks

Demonstrate the fabrication of jig and fixture components by:

- turning
- milling
- surface grinding
- cylindrical grinding
- jig boring

Demonstrate fitting, positioning, and aligning of components:

- running
- sliding
- locational
- interference
- clearance fits

60.7 Demonstrate jig and fixture assembly procedures. (24 hrs)

Identify the sequence of sub and final assembly.

Perform holding and aligning of mating jig and fixture components.

Perform the lay out, fit, and fastening of jig and fixture components.

Perform the lay out, fitting, and fastening of jig and fixture sub-assemblies for final assembly.

Demonstrate the final assembly using completed sub-assemblies.

Demonstrate procedures for testing, modifying, and adjusting of jig and fixture assemblies.

Identify the accuracy and mechanical functioning of jig and fixture assemblies.

Evaluation Structure		
Theory Testing	Practical Application Testing	Final Assessment
40%	60%	100%



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Tool and Die Maker