



**Skilled  
Trades**  
Ontario

**Métiers  
spécialisés**  
Ontario

Apprenticeship  
Curriculum Standard

Tool and Die Maker  
Tool/Tooling Maker

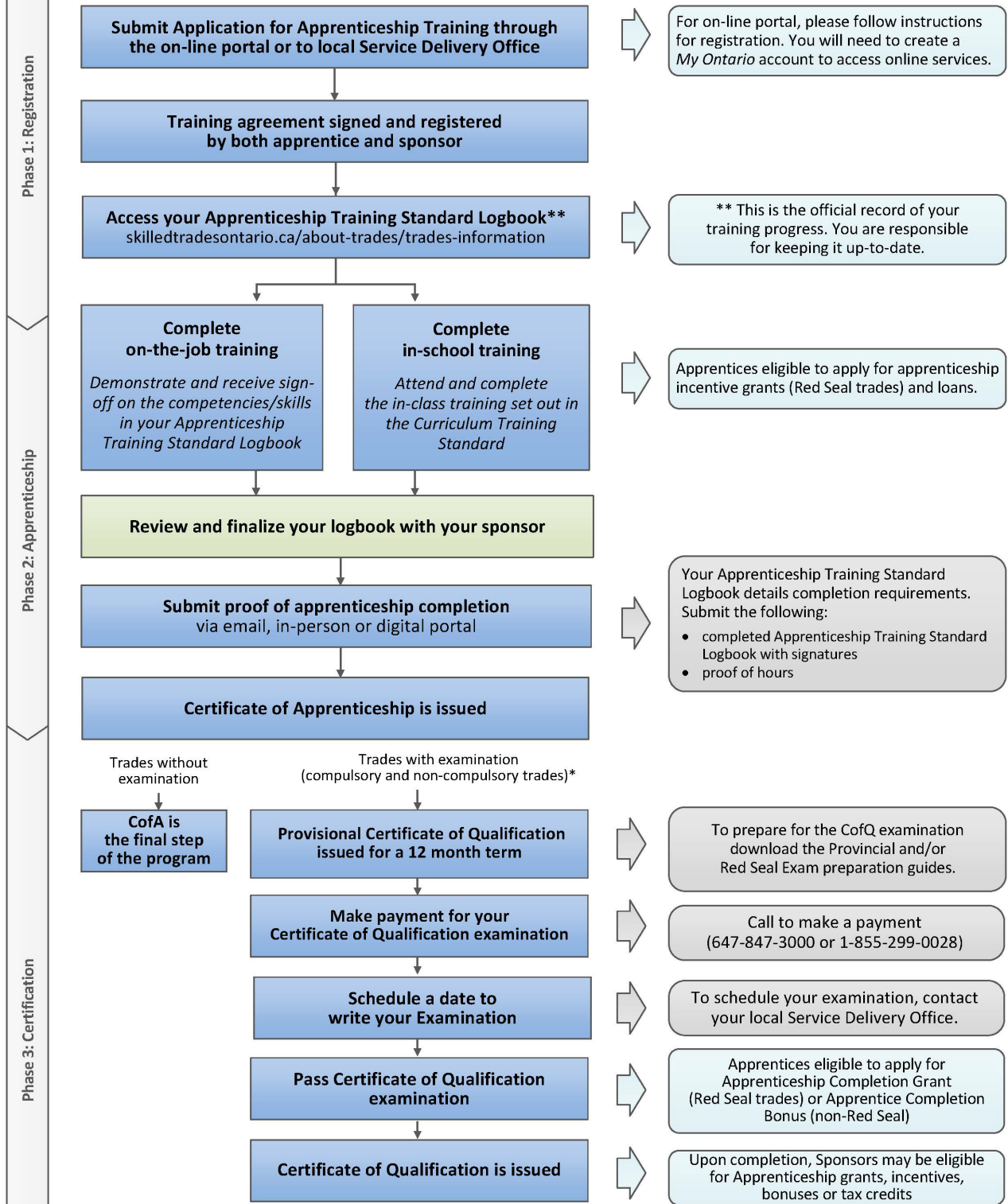
Level 3 Advanced

430A & 630T

2008



# Apprenticeship Pathway to a Certificate of Qualification



\* For a list of trades subject to a certification examination, visit: [skilledtradesontario.ca](http://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](http://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](http://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 third 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](http://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 3

**Reportable Subject Summary – Level 3**

<b>Number</b>	<b>Reportable Subjects</b>	<b>Hours Total</b>	<b>Hours Theory</b>	<b>Hours Practical</b>
S0661	Applied Trade Calculations, Charts, Tables	24	24	0
S0662	Complex Engineering Drawings/CAD Data	30	12	18
S0663	Metallurgy of Tool or Die Components	12	8	4
S0664	Metrology (Measuring and Checking)	6	3	3
S0665	CNC Technology for Option A - Machining Centre and Option B - Ram/Sink or Wire EDM	30	24	6
S0666	Stamping Technology	21	21	0
S0667	Mechanical Assembly Technology for Tooling or Die Making	30	18	12
S0668	Tooling or Die Building Technology and Processes	87	27	60
	<b>Total</b>	<b>240</b>	<b>137</b>	<b>103</b>

<b>Number:</b>	S0661		
<b>Title:</b>	<b>Applied Trade Calculations, Charts, Tables</b>		
<b>Duration:</b>	Total Hours: 24	Theory: 24	Practical: 0
<b>Prerequisites:</b>	L1 CC: S0601, S0602, S0603, S0604, S0605, S0606, S0607, S0608, S0609, S0610, S0611 L2: S0649, S0650, S0651, S0652, S0653, S0654, S0655, S0656, S0657, S0658, S0659, S0660		
<b>Content:</b>	S0661.1	Solve trade-specific problems involving oblique triangles and solve for unknown values. (6 hrs)	
	S0661.2	Solve trade-specific problems involving the law of sines and solve for unknown values. (6 hrs)	
	S0661.3	Solve trade-specific problems involving the law of cosines and cotangents and solve for unknown values. (8 hrs)	
	S0661.4	Solve trade-specific problems involving compound angles. (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:** Shop Text Books  
Technology of Machine Tools  
Basic and Advanced Tool & Die Making  
Mathematics for Machining Technology

Number:	S0661.0		
Title:	<b>Applied Trade Calculations, Charts, Tables</b>		
Duration:	Total Hours: 24	Theory: 24	Practical: 0

### General Learning Outcomes

Upon successful completion the apprentice is able to solve tooling and die related problems using oblique triangle trigonometry, law of sines, law of cosines/cotangents, and compound angles; and solve for unknown values.

### Learning Outcomes and Content

61.1 Solve trade-specific problems involving oblique triangles and solve for unknown values. (6 hrs)

Describe an oblique triangle.

Calculate the values of the unknown sides of oblique triangles.

61.2 Solve trade-specific problems involving the law of sines and solve for unknown values. (6 hrs)

Describe the law of sines.

Calculate the values of unknown sides and angles of oblique triangles using the law of sines:

- values of two angles and one side
- values of two sides and one angle

61.3 Solve trade-specific problems involving the law of cosines and cotangents and solve for unknown values. (8 hrs)

Describe the law of cosines and cotangents.

Calculate the values of the unknown sides and angles of oblique triangles using the law of cosines and cotangents:

- values of two sides and the included angle
- values of three sides

61.4 Solve trade-specific problems involving compound angles. (4 hrs)

Describe compound angles.

Calculate the values of compound angles of tilt and rotation.

<b>Evaluation Structure</b>		
<b>Theory Testing</b>	<b>Practical Application Testing</b>	<b>Final Assessment</b>
100%	0%	100%

<b>Number:</b>	S0662		
<b>Title:</b>	<b>Complex Engineering Drawings/CAD Drawings</b>		
<b>Duration:</b>	Total Hours: 30	Theory: 12	Practical: 18
<b>Prerequisites:</b>	L1 CC: S0601, S0602, S0603, S0604, S0605, S0606, S0607, S0608, S0609, S0610, S0611 L2: S0649, S0650, S0651, S0652, S0653, S0654, S0655, S0656, S0657, S0658, S0659, S0660		
<b>Content:</b>	S0662.1	Interpret tooling or die component prints and CAD data. (6 hrs)	
	S0662.2	Interpret tooling or die assembly prints and CAD data. (6 hrs)	
	S0662.3	Interpret tooling or die product drawings, part prints and CAD data. (6 hrs)	
	S0662.4	Interpret tooling or die tables and charts. (6 hrs)	
	S0662.5	Develop a plan for the building and assembling of tooling or dies. (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:** Shop Text Books  
Technology of Machine Tools  
Basic and Advanced Tool & Die Making  
Interpreting Engineering Drawings

Number:	S0662.0		
Title:	<b>Complex Engineering Drawings/CAD Drawings</b>		
Duration:	Total Hours: 30	Theory: 12	Practical: 18

### General Learning Outcomes

Upon successful completion the apprentice is able to interpret tooling or die component drawings and CAD data; interpret tooling or die assembly prints and CAD data; interpret tooling or die product drawings, part prints, and CAD data; interpret tooling or die tables and charts; and, develop an operational plan for building and assembling tooling or dies.

### Learning Outcomes and Content

62.1 Interpret tooling or die component prints and CAD data. (6 hrs)

Identify the drawing scale of tooling and die components.

Describe types of dies:

- single operation
- compound
- combination
- progressive

Identify drawing specifications:

- machining allowances
- heat-treating
- welding

Interpret the language of component prints, symbols, abbreviations, and specifications:

- quantity
- bill of material
- graphic shape
- threads
- fasteners
- springs
- surface finish
- general and local notes
- revisions
- detail drawings
- heat-treating specifications



Calculate fractional, decimal, and metric dimensional values:

- shape
- fits
- allowances
- angles
- nominal sizes
- tolerances
- references
- concentricity
- squareness
- parallelism

Interpret tooling and die component prints and CAD data.

62.2 Interpret tooling or die assembly prints and CAD data. (6 hrs)

Identify types of systems and system components:

- feeding system
  - coil
  - hitch
  - transfer
  - strip
  - unit
- guiding system
  - pushers
  - guide rails
  - nests
  - stock lifters
- stock locating system
  - sight stops
  - trigger stops
  - solid stops (end)
  - finger stops
  - pin stops
  - pilots
- ejection system
  - shedders
  - kickers
  - knock-out pin (positive)
  - slug ejectors
  - air cylinders
  - gravity

- stock removal system
  - spring strippers
  - box strippers
  - open side strippers
  - hook strippers

Describe assembly dimensions and fits.

Interpret tooling and die prints and CAD data for assembly procedures.

62.3 Interpret tooling or die product drawings, part prints, and CAD data. (6 hrs)

Identify the symbols and abbreviations to determine:

- part material
- product material
- surface finish
- secondary operations

Calculate fractional, decimal, and metric dimensional values.

Determine specific part/product information:

- strip layout
- stock utilization
- grain direction

Identify general, local, and stamp-on notes.

Interpret tooling or die part drawings and product prints.

62.4 Interpret tooling or die tables and charts. (6 hrs)

Identify tooling or die table and chart representations and designations:

- standard gauges
  - sheet metal
  - wire
- bending allowances
- punching pressures
- cutting clearances
- angular clearances

Interpret specified tooling or die tables and charts by determining:

- types
- format
- contents
- magnitude (values)
- dimensions
- conditions
- alternatives
- tolerances
- limitations
- abbreviations
- terminology
- applications

62.5 Develop a plan for the building and assembling tooling or dies. (6 hrs)

Interpret engineering drawings and CAD data and develop a plan for machining methods and procedures.

Interpret engineering drawings and CAD data and develop a plan for operational sequences.

<b>Evaluation Structure</b>		
Theory Testing	Practical Application Testing	Final Assessment
40%	60%	100%

<b>Number:</b>	S0663		
<b>Title:</b>	<b>Metallurgy of Tooling or Die Components</b>		
<b>Duration:</b>	Total Hours: 12	Theory: 8	Practical: 4
<b>Prerequisites:</b>	L1 CC: S0601, S0602, S0603, S0604, S0605, S0606, S0607, S0608, S0609, S0610, S0611 L2: S0649, S0650, S0651, S0652, S0653, S0654, S0655, S0656, S0657, S0658, S0659, S0660		
<b>Content:</b>	S0663.1	Describe safe working procedures when working with heat-treating equipment.	
	S0663.2	Describe heat-treating processes. (6 hrs)	
	S0663.3	Demonstrate hand held heat-treating of tooling or die components. (4 hrs)	
	S0663.4	Describe the properties and characteristics of non-metallic materials. (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  
Technology of Machine Tools  
Basic and Advanced Tool & Die Making

<b>Number:</b>	S0663.0		
<b>Title:</b>	<b>Metallurgy of Tooling or Die Components</b>		
<b>Duration:</b>	Total Hours: 12	Theory: 8	Practical: 4

### General Learning Outcomes

Upon successful completion the apprentice is able to: describe heat-treating processes; demonstrate procedures for using hand held equipment for the hardening and tempering of tooling or die components; and, describe properties of non-metallic materials.

### Learning Outcomes and Content

63.1 Describe safe working procedures when working with heat-treating equipment.

Identify potential safety hazards which may occur during the setting up and operating of heat-treating procedures.

Identify heat-treating safety habits and protective equipment including:

- asbestos gloves
- asbestos aprons
- arm shields
- face shields
- checking workpieces
- toxic fumes
- safety rules
- accident reporting
- good housekeeping
- start-up
- shut-down
- securing and stabilizing workpiece
- lock-out and tagging procedures

63.2 Describe heat-treating processes. (6 hrs)

Describe the process and advantages of nitriding of alloy steels:

- heat-treating specifications
- nitriding process
- types of alloy steels
- toughness
- wear resistance
- machinability
- type of furnace
- depth of hardness
- quenching media
- quenching procedures

Describe the process and advantages of gas carburizing of parts:

- types of gases
- hardness
- toughness
- strength
- type of furnace
- quenching procedures
- heat-treating specification
- quenching media
- machinability
- type of metal

Describe the process and advantages of liquid carburizing of steel:

- heat-treating specifications
- quenching media
- quenching procedures
- hardness
- toughness
- strength
- materials

Describe the process and advantages for induction hardening:

- heat-treating specifications
- type of metal
- depth of hardness
- frequency levels
- toughness
- strength
- quenching media
- quenching procedures

63.3 Demonstrate hand held heat-treating of tooling or die components. (4 hrs)

Demonstrate torch flame hardening and tempering of metal components:

- heat-treating specifications
- hardening
- tempering
- tempering colours
- quenching media
- hardness
- surface preparation
- workpiece holding
- workpiece positioning
- flame characteristics
- quenching procedures

63.4 Describe the properties and characteristics of non-metallic materials. (2 hrs)

Describe the properties and characteristics of non-metallic materials:

- composites
- fibreglass
- carbon fibre
- plastics
- chemicals
- physical
- mechanical
- optical
- shapes
- sizes
- tolerances
- surface conditions

- SPE code classifications
- heating response
- machinability
- applications
- surface finish
- fumes

<b>Evaluation Structure</b>		
Theory Testing	Practical Application Testing	Final Assessment
60%	40%	100%



<b>Number:</b>	S0664		
<b>Title:</b>	<b>Metrology (Measuring and Checking)</b>		
<b>Duration:</b>	Total Hours: 6	Theory: 3	Practical: 3
<b>Prerequisites:</b>	L1 CC: S0601, S0602, S0603, S0604, S0605, S0606, S0607, S0608, S0609, S0610, S0611 L2: S0649, S0650, S0651, S0652, S0653, S0654, S0655, S0656, S0657, S0658, S0659, S0660		
<b>Content:</b>	S0664.1	Describe safe working procedures when setting up and operating measuring and checking equipment.	
	S0664.2	Describe the fundamentals of measuring, checking, and gauging equipment. (1 hr)	
	S0664.3	Describe the components, adjusting mechanisms, and working principles of an optical comparator and coordinate measuring machine (CMM). (1 hr)	
	S0664.4	Describe measuring and checking techniques using an optical comparator. (2 hrs)	
	S0664.5	Describe the functions and operating principles of coordinate measuring machine (CMM). (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  
Technology of Machine Tools  
Basic and Advanced Tool & Die Making

Number:	S0664.0		
Title:	<b>Metrology (Measuring and Checking)</b>		
Duration:	Total Hours: 6	Theory: 3	Practical: 3

### General Learning Outcomes

Upon successful completion the apprentice is able to describe the fundamentals of measuring, checking, and gauging equipment; describe the components, adjusting mechanisms, and working principles of an optical comparator and coordinate measuring machine (CMM); describe measuring and checking techniques using an optical comparator; and, describe the functions and operating principles of coordinate measuring machine (CMM).

### Learning Outcomes and Content

64.1 Describe safe working procedures when setting up and operating measuring and checking equipment.

Identify potential safety hazards which may occur during the setting up and operation of measuring and checking equipment.

Identify potential safety hazards which may occur during the setting up and operation of optical comparators and CMM.

Demonstrate safe work habits including:

- protective clothing
- protective equipment and gear
- good housekeeping
- stabilizing workpieces
- operation procedures
- securing work pieces
- storage and handling of equipment

64.2 Describe the fundamentals of measuring, checking, and gauging equipment. (1 hr)

Describe measuring, checking, and gauging equipment:

- compound sine plate
- precision level
- profilometer
- tooling balls
- dial test gauges
- mechanical comparator
- coordinate measuring machine (CMM)

64.3 Describe the components, adjusting mechanisms, and working principles of an optical comparator and coordinate measuring machine (CMM). (1 hr)

Describe parts and application of an optical comparator:

- surface illumination
- illumination mechanism
- table
- dials
- mylars
- screen
- micrometer dial
- read out
- angular settings/adjustments
- linear settings/adjustments
- locks
- magnification
- on/off

Describe the parts and application of a CMM:

- granite work table
- bridge
- head
- probe
- computer
- CAD surface data
- printer
- software interface
- joystick

64.4 Describe measuring and checking techniques using an optical comparator. (2 hrs)

Describe cleaning techniques of workpiece surfaces.

Identify features to be measured or checked.

Describe measurement and checking of geometric features.

Describe recording techniques.

64.5 Describe the functions and operating principles of coordinate measuring machine (CMM). (2 hrs)

Describe cleaning techniques of workpiece surfaces.

Describe calibration/orientation techniques.

Identify features to be measured or checked.

Describe recording techniques.

<b>Evaluation Structure</b>		
Theory Testing	Practical Application Testing	Final Assessment
50%	50%	100%

<b>Number:</b>	S0665		
<b>Title:</b>	<b>Computerized Numerical Controlled (CNC) Machining Centres (Option A)</b> <b>Or</b> <b>Ram/Sink or Wire Electrical Discharge Machining (EDM) (Option B)</b>		
<b>Duration:</b>	Total Hours: 30	Theory: 24	Practical: 6
<b>Prerequisites:</b>	L1 CC: S0601, S0602, S0603, S0604, S0605, S0606, S0607, S0608, S0609, S0610, S0611  L2: S0649, S0650, S0651, S0652, S0653, S0654, S0655, S0656, S0657, S0658, S0659, S0660		
<b>Content:</b>	S0665.1	Describe safe working procedures when setting up and operating CNC machining centres or EDM machines.	
	S0665.2	Describe operating principles and applications of CNC machining centres or EDM machines. (2 hrs)	
	S0665.3	Describe part programming methods, set-up sheets, tooling lists, part program manuscripts, and input media. (5 hrs)	
	S0665.4	Describe circular interpolation methods. (3 hrs)	
	S0665.5	Develop a plan for CNC machining centre or EDM machines programming. (5 hrs)	
	S0665.6	Demonstrate procedures for entering and verifying a program for a CNC machining centre or EDM machines. (15 hrs)	
	Note:	Options A and B will vary depending upon the availability of machine tools within the training centre.machine (CMM). (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  
Technology of Machine Tools  
Basic and Advanced Tool & Die Making  
CNC Technical Manuals

Number:	S0665.0		
Title:	<b>Option A: CNC Machining Centres</b>		
Duration:	Total Hours: 30	Theory: 24	Practical: 6

### General Learning Outcomes

Upon successful completion the apprentice is able to describe operating principles and applications of CNC machining centres; describe part programming methods, set-up sheets, tooling lists, part program manuscripts, and input media; describe circular interpolation methods; develop a plan for CNC machining centre programming; and, demonstrate procedures for entering and verifying CNC machining centre program.

### Learning Outcomes and Content

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

Identify potential safety hazards which may occur during the setting up and operation 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
- stabilizing workplace
- lubricants
- lock-out and tagging procedures

65.2 Describe operating principles and applications of CNC machining centres. (2 hrs)

Identify types of CNC machining centres.

Describe the capabilities of CNC machining centres:

- types of equipment
- editing capability
- program path ability
- processing power

Describe operating principles and applications of CNC machining centres.

Describe the major features and functions of CNC machining centres.

Describe the major features of a CNC manufacturing process.

65.3 Describe part programming methods, set-up sheets, tooling lists, part program manuscripts, and input media. (5 hrs)

Describe required documentation for CNC machining process:

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

Describe the individual components of a part program manuscript:

- sequence numbers
- preparatory and miscellaneous functions
- axis motions and 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 individual components of a set-up sheet:

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

Describe the individual components of a tooling list.



Describe the common means of producing part program files:

- manual programming
- CAM systems
- conversational programming

65.4 Describe circular interpolation methods. (3 hrs)

Describe circular interpolation planes:

- X B Y plane
- Z B X plane
- Y B Z plane
- arc centre modifiers

Describe circular interpolation commands:

- arc modifiers
- radius
- quadrants
- circles
- cutter radius compensation

65.5 Develop a plan for CNC machining centre programming. (5 hrs)

Interpret documentation to determine:

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

Plan sequence of machining by identifying:

- order of operations (where applicable)
- tooling requirements (where applicable)
- workpiece set-up

65.6 Demonstrate procedures for entering and verifying a program for a CNC machining centre. (15 hrs)

Demonstrate the use of preparatory commands (G-Codes).

Demonstrate the use of G-Codes in a block.

Demonstrate the use of M-Codes.

Demonstrate the use of codes to specify dimensions.

Demonstrate the use of codes to specify cutting medium function.

Demonstrate the use of codes to specify reference points.

Demonstrate the use of codes to produce a conforming part.

Demonstrate the use of common machine function controls:

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

<b>Evaluation Structure</b>		
Theory Testing	Practical Application Testing	Final Assessment
75%	25%	100%

<b>Number:</b>	S0665.0		
<b>Title:</b>	<b>Option B: EDM – Ram/Sink or Wire EDM</b>		
<b>Duration:</b>	Total Hours: 30	Theory: 24	Practical: 6

### General Learning Outcomes

Upon successful completion the apprentice is able to interpret EDM documentation and demonstrate procedures for entering and verifying an EDM program for a ram/sink or wire EDM machine.

### Learning Outcomes and Content

- 65.1 Describe safe working procedures when setting up and operating ram/sink or wire 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
  - operating procedures
  - start-up
  - shut-off
  - securing workpiece
  - stabilizing workplace
  - dielectric fluids
  - fire hazards
  - lock-out and tagging procedures

65.2 Describe operating principles and applications of ram/sink and wire EDM machines. (2 hrs)

Identify types of ram/sink and wire EDM machines.

Describe the capabilities of ram/sink and wire EDM machines:

- types of equipment
- editing capability
- program path ability
- processing power

Describe operating principles and applications of ram/sink and wire EDM machines controls.

Describe the major features and functions of ram/sink and wire EDM machines.

Describe the major features of an EDM manufacturing process.

65.3 Describe part programming methods, set-up sheets, tooling lists, part program manuscripts, and input media. (5 hrs)

Describe required documentation for EDM machining process:

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

Describe the individual components of a part program manuscript:

- sequence numbers
- preparatory and miscellaneous functions
- axis motions and 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 individual components of a set-up sheet:

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

Describe the individual components of a tooling list.

Describe the common means of producing part program files:

- manual programming
- CAM systems
- conversational programming

65.4 Describe circular interpolation method. (3 hrs)

Describe circular interpolation planes:

- X B Y plane
- Z B X plane
- Y B Z plane
- arc centre modifiers

Describe circular interpolation commands:

- arc modifiers
- radius
- quadrants
- circles
- cutter radius compensation

65.5 Develop a plan for EDM programming. (5 hrs)

Interpret documentation to determine:

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

Plan sequence of machining by identifying:

- order of operations (where applicable)
- tooling requirements (where applicable)
- workpiece set-up

65.6 Demonstrate procedures for entering and verifying a program for a ram/sink and wire EDM machine. (15 hrs)

Demonstrate the use of preparatory commands (G-Codes).

Demonstrate the use of G-Codes in a block.

Demonstrate the use of M-Codes.

Demonstrate the use of codes to specify dimensions.

Demonstrate the use of codes to specify cutting medium function.

Demonstrate the use of codes to specify reference points.

Demonstrate the use of codes to produce a conforming part.

Demonstrate the use of common machine function controls:

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

<b>Evaluation Structure</b>		
Theory Testing	Practical Application Testing	Final Assessment
75%	25%	100%

<b>Number:</b>	S0666		
<b>Title:</b>	<b>Stamping Technology</b>		
<b>Duration:</b>	Total Hours: 21	Theory: 21	Practical: 0
<b>Prerequisites:</b>	L1 CC: S0601, S0602, S0603, S0604, S0605, S0606, S0607, S0608, S0609, S0610, S0611 L2: S0649, S0650, S0651, S0652, S0653, S0654, S0655, S0656, S0657, S0658, S0659, S0660		
<b>Content:</b>	S0666.1	Describe die stamping operations. (5 hrs)	
	S0666.2	Describe die stamping tooling. (8 hrs)	
	S0666.3	Describe die stock material. (1 hr)	
	S0666.4	Describe punch presses and accessories. (7 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  
Technology of Machine Tools  
Basic and Advanced Tool & Die Making

Number:	S0666.0		
Title:	<b>Stamping Technology</b>		
Duration:	Total Hours: 21	Theory: 21	Practical: 0

### General Learning Outcomes

Upon successful completion the apprentice is able to describe die stamping operations; describe die stamping tooling; describe die stock materials; describe punch presses and accessories, and describe all the operational principles, design characteristics, features, and elements of metal stamping technology.

### Learning Outcomes and Content

66.1 Describe die stamping operations. (5 hrs)

Identify types of die stamping operations:

- cutting
- piercing
- bending
- forming
- drawing
- progressive

66.2 Describe die stamping tooling. (8 hrs)

Identify types of die sets:

- open
- back post
- diagonal post
- centre post
- four post
- heel type corner post

Identify die set terminology:

- die shoe
- punch shoe
- guide post
- bushing
- shank
- flange
- bolt slot
- die area
- shut height



Describe die stamping components:

- dies
- punches
- pilots
- stripper plates
- shedders
- pressure pads
- knockouts
- nest gauges
- stock guides
- pushers
- die stops
- springs
- fasteners
- keepers

66.3 Describe die stock materials. (1 hr)

Describe material types:

- ferrous
- non-ferrous
- non-metallic

Describe fabrication of stock material:

- Shearing
- slitting

66.4 Describe punch presses and accessories. (7 hrs)

Describe types of punch presses:

- gap frame (O.B.I.)
- straight-sided
- under drive
- high speed
- single-action
- double-action
- back-geared
- manual
- mechanical
- hydraulic
- pneumatic
- transfer

Describe punch press terminology:

- bolster plate
- ram
- frame
- fly wheel
- tonnage
- stroke
- cycle
- shut height
- die cushion

Describe stock material feeding and handling equipment:

- reel
- cradle
- ram feed
- hitch feed
- hopper feed
- dial feed
- magazine feed
- cam feed
- chute
- slide
- combination feeding
- straightening machine

<b>Evaluation Structure</b>		
Theory Testing	Practical Application Testing	Final Assessment
100%	0%	100%

<b>Number:</b>	S0667		
<b>Title:</b>	<b>Mechanical Assembly Technology for Tooling or Die Making</b>		
<b>Duration:</b>	Total Hours: 30	Theory: 18	Practical: 12
<b>Prerequisites:</b>	L1 CC: S0601, S0602, S0603, S0604, S0605, S0606, S0607, S0608, S0609, S0610, S0611		
	L2: S0649, S0650, S0651, S0652, S0653, S0654, S0655, S0656, S0657, S0658, S0659, S0660		
<b>Content:</b>	S0667.1	Describe safe working procedures when mechanically assembling components.	
	S0667.2	Describe procedures for setting up equipment and accessories for fitting, positioning, and aligning components. (2 hrs)	
	S0667.3	Describe the application of keyed assemblies. (1 hr)	
	S0667.4	Describe the application of dowelled assemblies. (1 hr)	
	S0667.5	Describe the application of types of fit. (2 hrs)	
	S0667.6	Describe the assembly of rack and pinion combinations. (10 hrs)	
	S0667.7	Describe the assembly of transfer systems. (3.5 hrs)	
	S0667.8	Describe the assembly of cam and follower combinations. (3.5 hrs)	
	S0667.9	Describe the assembly of cam and follower slides. (3.5 hrs)	
	S0667.10	Describe the assembly of in-die electronics. (3.5 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:** Shop Text Books  
Technology of Machine Tools  
Basic and Advanced Tool & Die Making

<b>Number:</b>	S0667.0		
<b>Title:</b>	<b>Mechanical Assembly Technology for Tooling or Die Making</b>		
<b>Duration:</b>	Total Hours: 30	Theory: 18	Practical: 12

### General Learning Outcomes

Upon successful completion the apprentice is able to describe procedures for setting up equipment and accessories for fitting, positioning, and aligning components; describe the application of keyed assemblies; describe the application of dowelled assemblies; describe the application of types of fits; describe processes and techniques for the assembly of rack and pinion combinations; describe processes and techniques for the assembly of transfer systems; describe processes and techniques for the assembly of cam and follower combinations; and, describe processes and techniques for the assembly of in-dies electronics.

### Learning Outcomes and Content

67.1 Describe safe working procedures when mechanically assembling components.

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

Demonstrate safe working habits including:

- protective clothing
- protective equipment and gear
- good housekeeping
- setting up of jigs and fixtures
- securing and stabilizing workpiece
- securing and stabilizing assembly components
- securing and stabilizing tools and equipment
- lubricants
- material handling equipment

67.2 Describe procedures for setting up equipment and accessories for fitting, positioning, and aligning components. (2 hrs)

Identify items to be used for the fitting and assembly of dies or tooling:

- equipment
- attachments
- workholding devices
- hand tools
- power tools
- material handling equipment

Describe set up procedures for equipment and accessories.

67.3 Describe the application of keyed assemblies. (1 hr)

Identify types and application of keyed assemblies.

Describe the application of keyed assemblies.

67.4 Describe the application of dowelled assemblies. (1 hr)

Identify types and application of dowelled assemblies.

Describe the application of keyed assemblies.

67.5 Describe the application of types of fit. (2 hrs)

Identify types and application of different types of fit.

Describe the application of different types of fit.

67.6 Describe the assembly of rack and pinion combinations. (10 hrs)

Identify rack and pinion combinations by determining:

- application
- design characteristics
- components
- tooth pitch
- rack and pinion ratio
- dimensional values of linear/radial movements
- types
- size
- activating mechanism
- activating motion
- fits
- tolerances

Describe the working operating principles and design parameters of rack and pinion combinations

Plan the assembly of rack and pinion combinations by determining:

- types of tooling/equipment
- size of tooling/equipment
- location
- relative position
- pitch line
- sequence of assembly
- use of lubricants
- workholding

Describe the assembly of rack and pinion combinations.

67.7 Describe the assembly of transfer systems. (3.5 hrs)

Describe transfer feed assemblies:

- single action
- dual action
- quad action
- tri-action

Plan assembly of transfer systems:

- part carriers
- pass-line
- types of end effectors
- timing

67.8 Describe the assembly of cam and follower combinations. (3.5 hrs)

Describe the operating principles and design parameters of cam and follower combinations.

Identify the required cam and follower combinations by determining:

- application
- design characteristics
- components
- type
- shape
- interrelated motions
- direction
- throw distance
- guides
- fasteners

- activating mechanism
- dwell
- motion
- fits
- tolerances

Develop a plan for the assembly of cam and follower combinations by determining:

- types of tool or equipment
- sizes of tooling or equipment
- locations
- relative engaging positions
- sequence of assembly
- use of lubricants
- piece part workholding

Describe the assembly of cam and follower combinations:

- linear
- rotary
- side
- aerial

67.9 Describe assembly of cam and follower slides. (3.5 hrs)

Describe cam slide combinations:

- side
- aerial
- lever
- hydro
- box
- bump

Develop a plan for the assembly of cam slides:

- guiding systems
- mounting techniques
- materials
- calculating cam travel



67.10 Describe the assembly of in-die electronics. (3.5 hrs)

Describe in-die electronics:

- digital
- analog
- shielded
- unshielded

Develop a plan for the assembly of in-die electronics:

- displacement
- mounting procedures
- location parameters
- noise

<b>Evaluation Structure</b>		
<b>Theory Testing</b>	<b>Practical Application Testing</b>	<b>Final Assessment</b>
60%	40%	100%

Number:	S0668		
Title:	<b>Tooling or Die Building Technology and Processes</b>		
Duration:	Total Hours: 87	Theory: 27	Practical: 60
Prerequisites:	L1 CC: S0601, S0602, S0603, S0604, S0605, S0606, S0607, S0608, S0609, S0610, S0611		
	L2: S0649, S0650, S0651, S0652, S0653, S0654, S0655, S0656, S0657, S0658, S0659, S0660		
Content:	S0668.1	Describe safe working habits when performing tooling or die building procedures.	
	S0668.2	Set up equipment and accessories for fitting, positioning, and aligning components. (2 hrs)	
	S0668.3	Describe blank development operations. (4 hrs)	
	S0668.4	Interpret engineering drawings, CAD data, component prints, assembly, and part drawings. (2 hrs)	
	S0668.5	Perform tooling or die related calculations. (2 hrs)	
	S0668.6	Demonstrate sketching of a detailed tooling or die component. (6 hrs)	
	S0668.7	Identify tooling or die component materials. (3 hrs)	
	S0668.8	Develop a plan for the tooling or die building process. (4 hrs)	
	S0668.9	Perform lay out of tooling or die components. (3 hrs)	
	S0668.10	Produce parts of tooling or a die. (19 hrs)	
	S0668.11	Describe processes for fitting, positioning, and aligning of components. (4 hrs)	
	S0668.12	Demonstrate tooling or die component assembly procedures. (15 hrs)	
	S0668.13	Identify punch press systems and controls. (5 hrs)	
	S0668.14	Describe types and operating principles of try- out presses. (8 hrs)	
	S0668.15	Describe installation procedures for putting components in press. (3 hrs)	
	S0668.16	Describe try-out procedures and processes. (3 hrs)	
	S0668.17	Describe techniques for finishing tooling and dies. (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:** Shop Text Books  
Technology of Machine Tools  
Basic and Advanced Tool & Die Making

Number:	S0668.0		
Title:	<b>Tooling or Die Building Technology and Processes</b>		
Duration:	Total Hours: 87	Theory: 27	Practical: 60

### General Learning Outcomes

Upon successful completion the apprentice is able to build, assemble, and describe the try-out of tooling or dies.

### Learning Outcomes and Content

68.1 Describe safe working habits when performing tooling or die building procedures.

Identify potential safety hazards which may occur during the building, assembling, and try-out of tooling or dies.

Demonstrate safe working habits including:

- protective clothing
- protective equipment and gear
- good housekeeping
- start-up
- shut-down
- securing workpiece
- stabilizing of workpiece
- try-out press installation
- material handling equipment
- lock out and tagging procedures

68.2 Set up equipment and accessories for fitting, positioning, and aligning components. (2 hrs)

Describe equipment to be used for fitting and assembly of components. Identify workholding devices:

- mandrels
- vises
- angle plates
- sine bars
- grinding chucks

Identify hand tools:

- files
- reamers
- stones
- laps

68.3 Describe blank development operations. (4 hrs)

Describe the purpose of blank development:

- determining effect of metal flow
- comparison of die function to part specifications
- determining sequence of die operation
- determining dimensions of final piece
- determining required stock material dimensions

Describe the effect of metal flow:

- drawing and bending radii
- draw speed (press velocity)
- depth of draw
- drawing pressure
- stock material required
- shape of component
- shape of part
- modifications to blank
- use of lubrication

68.4 Interpret engineering drawings, CAD data, component prints, assembly, and part drawings. (2 hrs)

Interpret engineering drawings and CAD data for die set or tooling assembly.

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

Identify die set features and components:

- open
- back post
- diagonal post
- centre post
- four post
- heel type corner post
- die shoe
- punch shoe
- guide post

- bushing
- shank
- flange
- bolt slot
- die area
- shut height

Identify tooling features and components:

- type of tooling
- tolerances
- sizes
- diameters
- number of working components
- number of functions
- assembly process

68.5 Perform tooling or die related calculations. (2 hrs)

Determine the die dimensions or press component and values by identifying:

- cutting clearances
- bending allowances
- contractions
- expansion variables
- shear angles
- stripping pressures
- tonnage
- draw calculations

Perform tooling or die related calculations to identify:

- lines
  - intersecting
  - parallel line
  - angle theorems
- triangles
  - congruency
  - angle
  - similarity postulation
- polygons
- circles
- surface areas of polyhedrons
- volumes of polyhedrons
- oblique angles
- right angles
- compound angles

68.6 Demonstrate sketching of a detailed tooling or die component. (6 hrs)

Develop hand sketches from piece-part specifications to illustrate component details:

- shape
- dimensions
- tolerances
- finishes
- assembly interrelationships

68.7 Identify tooling or die component materials. (3 hrs)

Interpret engineering drawings and CAD data to determine required die component material:

- type of material
- grade of material
- dimensions
- surface condition
- hardenability
- machinability
- heat-treating requirements

68.8 Develop a plan for the tooling or die building process. (4 hrs)

Develop a plan for building tooling or a die that identifies:

- machine tools
- try-out press
- hand and power tools
- measuring and checking equipment
- accessories
- machining processes
- machining procedures
- sequencing of machining
- tooling aids
- blank development
- tooling build sequence
- die building sequence
- fitting procedures
- assembly procedures
- fabrication processes
- heat treating processes

68.9 Perform lay out of tooling or die components. (3 hrs)

Describe layout of die components:

- die
- punches
- pilots
- stripper plates
- shedders
- pressure pads
- knockouts
- nest gauges
- stock guides
- pushers
- die stops
- springs
- fasteners

Describe layout of tooling components:

- shafts
- pulleys
- levers
- pins
- springs
- brackets
- bushings
- couplings
- fasteners
- tubes
- flanges
- housings
- plates
- blocks
- vessels
- guide ways
- specialized tools
- cutting tools
- forming tools
- tooling holders
- models
- specimens

Perform tooling or die component layout operations.



68.10 Produce parts of tooling or a die. (19 hrs)

Demonstrate machining to produce tooling or die components:

- milling
  - shapes and profiles
  - producing slots
  - indexing
  - gear cutting
  - duplicating
- drilling
- turning
  - bore
  - thread
  - form profiles
  - groove/recess/undercut
- grinding
  - flat surfaces
  - vertical surfaces
  - cylinders
  - internal
  - jig grinding
  - sharpen end mills
- jig boring
- honing
- lapping

Demonstrate heat-treating processes:

- hardening
- tempering
- annealing

Demonstrate verification procedures using:

- engineering drawings
- CAD data
- optical comparators
- compound sine plate
- precision level
- profilometer
- tooling balls
- dial test gauges
- mechanical comparator
- coordinate measuring machine (CMM)

68.11 Describe processes for fitting, positioning, and aligning components. (4 hrs)

Identify tools, measuring and checking equipment to be used for the fitting, positioning, and aligning of components.

Identify machining processes to be used for fitting, positioning, and aligning components:

- turning
- drilling
- milling
- surface grinding
- cylindrical grinding
- jig boring
- jig grinding
- EDM
- try-out press

68.12 Demonstrate tooling or die component assembly procedures. (15 hrs)

Identify the sequencing procedures used for sub and final assemblies.

Demonstrate procedures to hold and align the mating components.

Demonstrate layout, fit, and fastening of components and sub-assemblies.

Demonstrate the layout, fit, and fastening of sub-assemblies for final assembly.

68.13 Identify punch press systems and controls. (5 hrs)

Identify punch press safety systems and controls:

- electrical control systems and components
- mechanical systems and components
- pneumatic systems and components
- hydraulic systems and components
- fixed barrier
- die enclosure guards
- pull-out device
- two-hand control device
- electronic safety device
- double-sweep device
- operational procedures

68.14 Describe types and operating principles of try-out presses. (8 hrs)

Identify try-out press types by determining:

- mechanical
- hydraulic
- pneumatic
- manual

Describe try-out press characteristics by determining:

- frame (characteristics)
- size
- tonnage
- ram action
  - single
  - double
  - triple
- stem hole diameter
- press shut height
- total ram adjustment
- stroke distance
- bolster plate thickness
- depth of bed
- bed opening
- throat depth
- position of stroke
- ram adjustment
- location of dies between bolster plate and ram

Describe operating principles of presses:

- types of drive
- functions of main components
- locations of main components
- controls
- accessories
- ram strokes per minute
- material feed
- stops
- locating pins
- lubrication

68.15 Describe installation procedures for putting components in the press. (3 hrs)

Describe procedures for installing components in press:

- alignment procedures
- manual press cycle
- workpiece holding procedures
- securing procedures
- stock feed mechanism
- safety practices
- material handling equipment

68.16 Describe try-out procedures and processes. (3 hrs)

Describe methods and procedures for verifying the piece-part.

Identify causes of malfunctions or failures:

- burrs due to punch and die misalignment
- burrs due to insufficient clearance
- burrs due to excessive clearance
- misalignment of assemblies
- slug lifting
- spring back
- deformed holes
- incorrect position of holes
- piece-part ejection
- product ejection
- buckling
- scalloped edges
- puckering
- wrinkling
- concave bottom in part/product
- try-out press malfunction

68.17 Describe techniques for finishing tooling and dies. (4 hrs)

Describe procedures for using abrasive hand stones by determining:

- types
- abrasive size
- abrasive type
- shapes
- sizes
- profile
- composition
- lubricants
- material removal
- surface finish requirements
- surface condition

Describe procedures for using polishing abrasive compounds by determining:

- abrasive size
- abrasive type
- polishing characteristics
- lubrication
- material removal
- surface finish requirements
- surface condition
- finishing sequence

Describe hand or power finishing techniques by determining:

- lay direction of surface finish
- direction of metal flow in drawing operation
- finish allowances
- abrasive types
- abrasive sizes
- ejection path
- stripping of stock
- surface finish requirements
- punch condition
- die condition
- component condition
- material removal
- profile
- lubricant
- speeds

<b>Evaluation Structure</b>		
Theory Testing	Practical Application Testing	Final Assessment
30%	70%	100%



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Tool and Die Maker