Apprenticeship
Curriculum Standard

General Machinist

Level 3-Advanced

Trade Code: 429A

Date: 2008
Please Note: Apprenticeship Training and Curriculum Standards were developed by the Ministry of Training, Colleges and Universities (MTCU). As of April 8th, 2013, the Ontario College of Trades (College) has become responsible for the development and maintenance of these standards. The College is carrying over existing standards without any changes.

However, because the Apprenticeship Training and Curriculum Standards documents were developed under either the Trades Qualification and Apprenticeship Act (TQAA) or the Apprenticeship and Certification Act, 1998 (ACA), the definitions contained in these documents may no longer be accurate and may not be reflective of the Ontario College of Trades and Apprenticeship Act, 2009 (OCTAA) as the new trades legislation in the province. The College will update these definitions in the future.

Meanwhile, please refer to the College’s website (http://www.collegeoftrades.ca) for the most accurate and up-to-date information about the College. For information on OCTAA and its regulations, please visit: http://www.collegeoftrades.ca/about/legislation-and-regulations
# TABLE OF CONTENTS

## Introduction

Introduction ........................................................................................................................................ 1

## Program Summary of Reportable Subjects

<table>
<thead>
<tr>
<th>S0620.0</th>
<th>Applied Trade Calculations, Charts, Tables</th>
<th>....................................................... 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>S0620.1</td>
<td>Solve trade-specific problems involving oblique triangles and solve for unknown values</td>
<td>....................................................... 4</td>
</tr>
<tr>
<td>S0620.2</td>
<td>Solve trade-specific problems involving the law of sines and solve for unknown values</td>
<td>....................................................... 4</td>
</tr>
<tr>
<td>S0620.3</td>
<td>Solve trade-specific problems involving the law of cosines and cotangents and solve for unknown values</td>
<td>....................................................... 5</td>
</tr>
<tr>
<td>S0620.4</td>
<td>Solve trade-specific problems involving compound angles</td>
<td>....................................................... 5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>S0621.0</th>
<th>Complex Engineering Drawings, CAD Data</th>
<th>....................................................... 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>S0621.1</td>
<td>Identify sectional views</td>
<td>....................................................... 7</td>
</tr>
<tr>
<td>S0621.2</td>
<td>Describe the ISO system of limits and fits as applied to features of a workpiece</td>
<td>....................................................... 7</td>
</tr>
<tr>
<td>S0621.3</td>
<td>Describe geometric dimensioning and tolerancing symbols and terminology</td>
<td>....................................................... 8</td>
</tr>
<tr>
<td>S0621.4</td>
<td>Interpret geometric drawing symbols</td>
<td>....................................................... 10</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>S0622.0</th>
<th>Metallurgy</th>
<th>....................................................... 11</th>
</tr>
</thead>
<tbody>
<tr>
<td>S0622.1</td>
<td>Describe safe working procedures when working with heat-treating equipment</td>
<td>....................................................... 12</td>
</tr>
<tr>
<td>S0622.2</td>
<td>Describe ferrous metal heat-treating processes</td>
<td>....................................................... 13</td>
</tr>
<tr>
<td>S0622.3</td>
<td>Describe the properties and characteristics of non-metallic materials</td>
<td>....................................................... 14</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>S0623.0</th>
<th>Metrology (Measuring and Checking)</th>
<th>....................................................... 15</th>
</tr>
</thead>
<tbody>
<tr>
<td>S0623.1</td>
<td>Describe safe working procedures when setting up and operating measuring and checking equipment</td>
<td>....................................................... 17</td>
</tr>
<tr>
<td>S0623.2</td>
<td>Describe the fundamentals of measuring, checking, and gauging equipment</td>
<td>....................................................... 18</td>
</tr>
<tr>
<td>S0623.3</td>
<td>Describe the components, adjusting mechanisms, and working principles of an optical comparator</td>
<td>....................................................... 18</td>
</tr>
<tr>
<td>S0623.4</td>
<td>Set up workholding devices and accessories for an optical comparator</td>
<td>....................................................... 19</td>
</tr>
<tr>
<td>S0623.5</td>
<td>Describe terminology and measuring techniques for an optical comparator</td>
<td>....................................................... 19</td>
</tr>
<tr>
<td>S0623.6</td>
<td>Demonstrate operational procedures for an optical comparator</td>
<td>....................................................... 20</td>
</tr>
<tr>
<td>S0623.7</td>
<td>Demonstrate measuring and checking techniques using an optical comparator</td>
<td>....................................................... 20</td>
</tr>
<tr>
<td>S0623.8</td>
<td>Describe the functions and operating principles of Coordinate Measuring Machines (CMM)</td>
<td>....................................................... 20</td>
</tr>
<tr>
<td>Code</td>
<td>Description</td>
<td>Page</td>
</tr>
<tr>
<td>-------</td>
<td>------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>S0624.0</td>
<td><strong>Complex Turning Technology</strong></td>
<td>21</td>
</tr>
<tr>
<td>S0624.1</td>
<td>Describe safe working procedures when setting up and operating a lathe</td>
<td>22</td>
</tr>
<tr>
<td>S0624.2</td>
<td>Describe lathe workholding devices, attachments, and accessories</td>
<td>22</td>
</tr>
<tr>
<td>S0624.3</td>
<td>Describe lathe cutting, trepanning, and forming tools, and tool holders</td>
<td>23</td>
</tr>
<tr>
<td>S0624.4</td>
<td>Develop a plan for lathe machining</td>
<td>23</td>
</tr>
<tr>
<td>S0624.5</td>
<td>Perform turning</td>
<td>24</td>
</tr>
<tr>
<td>S0624.6</td>
<td>Perform routine maintenance</td>
<td>25</td>
</tr>
<tr>
<td>S0625.0</td>
<td><strong>Complex Milling Technology</strong></td>
<td>26</td>
</tr>
<tr>
<td>S0625.1</td>
<td>Describe safe working procedures when setting up and operating milling machines</td>
<td>27</td>
</tr>
<tr>
<td>S0625.2</td>
<td>Identify milling attachments used for complex milling operations</td>
<td>27</td>
</tr>
<tr>
<td>S0625.3</td>
<td>Develop a plan for complex milling operations</td>
<td>28</td>
</tr>
<tr>
<td>S0625.4</td>
<td>Describe procedures for using mill workholding devices and accessories</td>
<td>29</td>
</tr>
<tr>
<td>S0625.5</td>
<td>Describe the assembly of cutting tools and tool holders for complex milling operations</td>
<td>29</td>
</tr>
<tr>
<td>S0625.6</td>
<td>Demonstrate complex milling operations</td>
<td>30</td>
</tr>
<tr>
<td>S0625.7</td>
<td>Perform routine maintenance</td>
<td>30</td>
</tr>
<tr>
<td>S0626.0</td>
<td><strong>Complex Grinding Technology</strong></td>
<td>31</td>
</tr>
<tr>
<td>S0626.1</td>
<td>Describe safe working procedures when setting up and operating grinders</td>
<td>32</td>
</tr>
<tr>
<td>S0626.2</td>
<td>Describe internal grinding techniques and processes</td>
<td>32</td>
</tr>
<tr>
<td>S0626.3</td>
<td>Identify workholding devices and/or attachments used for internal grinding</td>
<td>33</td>
</tr>
<tr>
<td>S0626.4</td>
<td>Describe grinding wheels used for internal grinding and sharpening of end mills</td>
<td>33</td>
</tr>
<tr>
<td>S0626.5</td>
<td>Develop a plan for internal grinding and sharpening of end mills</td>
<td>34</td>
</tr>
<tr>
<td>S0626.6</td>
<td>Demonstrate internal grinding and end mill sharpening</td>
<td>34</td>
</tr>
<tr>
<td>S0626.7</td>
<td>Perform routine maintenance</td>
<td>34</td>
</tr>
<tr>
<td>Code</td>
<td>Description</td>
<td>Page</td>
</tr>
<tr>
<td>-----------</td>
<td>-------------------------------------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>S0627.0</td>
<td>Machining Centre CNC Technology</td>
<td>35</td>
</tr>
<tr>
<td>S0627.1</td>
<td>Describe safe working procedures when setting up and operating CNC machining centres</td>
<td>37</td>
</tr>
<tr>
<td>S0627.2</td>
<td>Describe operating principles of CNC machining centres</td>
<td>38</td>
</tr>
<tr>
<td>S0627.3</td>
<td>Describe use of job documentation to determine job requirements</td>
<td>38</td>
</tr>
<tr>
<td>S0627.4</td>
<td>Describe the application of machining centres</td>
<td>39</td>
</tr>
<tr>
<td>S0627.5</td>
<td>Describe machining centre operations</td>
<td>39</td>
</tr>
<tr>
<td>S0627.6</td>
<td>Describe manual operating systems for CNC machining centres</td>
<td>40</td>
</tr>
<tr>
<td>S0627.7</td>
<td>Describe circular interpolation on a machining centre</td>
<td>40</td>
</tr>
<tr>
<td>S0627.8</td>
<td>Develop a plan for CNC machining centres</td>
<td>41</td>
</tr>
<tr>
<td>S0627.9</td>
<td>Describe the setting up and application of workholding devices for CNC machining centre operations</td>
<td>41</td>
</tr>
<tr>
<td>S0627.10</td>
<td>Demonstrate procedures for entering and verifying programs for a CNC machining centre to perform linear and circular machining operations</td>
<td>41</td>
</tr>
</tbody>
</table>
Introduction

This revised curriculum standard for the Level 3 – General Machinist for the Machining and Tooling trade program is based upon the on-the-job performance objectives, located in the industry approved training standard.

The curriculum is organized into 8 reportable subjects. The Program Summary of Reportable Subjects chart summarizes the training hours for each reportable subject. The curriculum identifies only the learning that takes place off-the-job. 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 the work site. Regular evaluations of the apprentice’s knowledge and skills are conducted throughout training to ensure 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.
# Program Summary of Reportable Subjects – Level 3

<table>
<thead>
<tr>
<th>Number</th>
<th>Reportable Subjects</th>
<th>Hours Total</th>
<th>Hours Theory</th>
<th>Hours Practical</th>
</tr>
</thead>
<tbody>
<tr>
<td>S0620</td>
<td>Applied Trade Calculations, Charts, Tables</td>
<td>36</td>
<td>36</td>
<td>0</td>
</tr>
<tr>
<td>S0621</td>
<td>Complex Engineering Drawings/CAD Data</td>
<td>42</td>
<td>24</td>
<td>18</td>
</tr>
<tr>
<td>S0622</td>
<td>Metallurgy</td>
<td>6</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>S0623</td>
<td>Metrology (Measuring and Checking)</td>
<td>6</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>S0624</td>
<td>Complex Turning Technology</td>
<td>42</td>
<td>10</td>
<td>32</td>
</tr>
<tr>
<td>S0625</td>
<td>Complex Milling Technology</td>
<td>42</td>
<td>10</td>
<td>32</td>
</tr>
<tr>
<td>S0626</td>
<td>Complex Grinding Technology</td>
<td>18</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>S0627</td>
<td>Machining Centre CNC Technology</td>
<td>48</td>
<td>24</td>
<td>24</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td></td>
<td><strong>240</strong></td>
<td><strong>129</strong></td>
<td><strong>121</strong></td>
</tr>
</tbody>
</table>
Number: S0620

Reportable Subject: APPLIED TRADE CALCULATIONS, CHARTS, TABLES

Duration: Total 36 hours Theory 36 hours Practical 0 hours

Prerequisites: L1 CC: S0601, S0602, S0603, S0604, S0605, S0606, S0607, S0608, S0609, S0610, S0611, L2: S0612, S0613, S0614, S0615, S0616, S0617, S0618, S0619,

Content: S0620.1 Solve trade-specific problems involving oblique triangles and solve for unknown values. (9 hrs)
S0620.2 Solve trade-specific problems involving the law of sines and solve for unknown values. (9 hrs)
S0620.3 Solve trade-specific problems involving the law of cosines and cotangents and solve for unknown values. (9 hrs)
S0620.4 Solve trade-specific problems involving compound angles. (9 hrs)

This module is intended to review appropriate mathematical principles as applied to trade-specific applications.

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

Mark Distribution:

<table>
<thead>
<tr>
<th></th>
<th>Theory Testing</th>
<th>Practical Application Testing</th>
<th>Final Assessment</th>
</tr>
</thead>
<tbody>
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<td>100 %</td>
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</tr>
</tbody>
</table>

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

GENERAL MACHINIST – LEVEL 3

S0620.0  Applied Trade Calculations, Charts, Tables

Duration:  Total 36 hours    Theory 36 hours    Practical 0 hours

Cross Reference to Training Standards:  GM 5231, U5232, U5233, U5234, U5235, U5236, U5237, U5238, U5239

GENERAL LEARNING OUTCOMES

Upon successful completion the apprentice is able to solve problems involving oblique triangle, law of sines, law of cosines/cotangents, and compound angles.

LEARNING OUTCOMES AND CONTENT

20.1 Solve trade-specific problems involving oblique triangles and solve for unknown values. (9 hrs)

Describe an oblique triangle.

Calculate the values of the unknown sides of oblique triangles.

20.2 Solve trade-specific problems involving the law of sines and solve for unknown values. (9 hrs)

Describe 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

20.3 Solve trade-specific problems involving the law of cosines and cotangents and solve for unknown values. (9 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
20.4 Solve trade-specific problems involving compound angles. (9 hrs)

Describe compound angles.

Calculate the values of compound angles for tilt and rotation.
Number: **S0621**

**Reportable Subject:** COMPLEX ENGINEERING DRAWINGS/CAD DATA

**Duration:**
- Total 42 hours
- Theory 24 hours
- Practical 18 hours

**Prerequisites:**
- L1 CC: S0601, S0602, S0603, S0604, S0605, S0606, S0607, S0608, S0609, S0610, S0611
- L2: S0612, S0613, S0614, S0615, S0616, S0617, S0618, S0619

**Content:**
- S0621.1 Identify sectional views. *(2 hrs)*
- S0621.2 Describe the ISO system of limits and fits as applied to features of a workpiece. *(8 hrs)*
- S0621.3 Describe geometric dimensioning and tolerancing symbols and terminology. *(30 hrs)*
- S0621.4 Interpret geometric drawing symbols. *(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

**Mark Distribution:**

<table>
<thead>
<tr>
<th></th>
<th>Theory Testing</th>
<th>Practical Application Testing</th>
<th>Final Assessment</th>
</tr>
</thead>
<tbody>
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<td><strong>%</strong></td>
<td>58 %</td>
<td>42%</td>
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</tr>
</tbody>
</table>

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

**Reference Materials:**
- Technology of Machine Tools
- Shop Text Books
- Interpreting Engineering Drawings
S0621.0 Complex Engineering Drawings/CAD Data

Duration: Total 42 hours Theory 24 hours Practical 18 hours

Cross Reference to Training Standards: GM 5231, U5232, U5233, U5234, U5235, U5236, U5237, U5238, U5239

GENERAL LEARNING OUTCOMES

Upon successful completion the apprentice is able to read and interpret geometric tolerancing and dimensioning on engineering drawings/CAD data.

LEARNING OUTCOMES AND CONTENT

21.1 Identify sectional views. (2 hrs)

Identify sectional conventions.

21.2 Describe the ISO system of limits and fits as applied to features of a workpiece. (8 hrs)

Describe ISO, standard limits, and fits:
- designation
- description
- clearance
- interference
- interchangeability
- nominal size
- standards
21.3 Describe geometric dimensioning and tolerancing symbols and terminology. 
(30 hrs)

Describe geometric dimensional and tolerancing terminology:
- regardless of feature size
- least material condition
- basic dimension
- datums
- feature control frame
- general rules
- virtual condition
- symbols
- individual and related features
- terms
- maximum material condition
- flatness
- straightness
- circularity
- cylindricity
- profile of a line
- profile of a surface
- perpendicularity
- angularity
- parallelism
- circular runout
- position
- concentricity
- coplanarity
- symmetry
- datum targets
- correlative tolerance

Describe geometric form control symbols:
- flatness
- straightness
- circularity
- cylindricity

Describe geometric profile control symbols:
- profile of a line
- profile of a surface
21.3 Continued

Describe geometric orientation control symbols:
- perpendicularity
- angularity
- parallelism

Describe geometric run-out control symbols:
- circular
- total

Describe geometric location control symbols:
- position
- concentricity
- symmetry

Describe geometric control symbols:
- coplanarity
- correlative tolerance

Describe geometric datum control:
- symbol
- target point
- target area
- line

Describe the feature control frame and the order of elements.

Describe the supplementary symbols:
- diameter
- radius
- reference
- counterbore/spotface
- square
- dimension origin
- projected tolerance zone
- spherical diameter
- spherical radius
- arc length
- counter sink
- depth
- conical taper
21.3 Continued

Describe datums:
- primary
- secondary
- tertiary
- axis
- minimum location points
- datum precedence

Describe material condition symbols:
- maximum material condition (MMC)
- regardless of feature size (RFS)
- least material condition (LMC)

Describe maximum material condition, least material condition, and regardless of feature size, with reference to the size of mating parts.

Describe virtual condition and the application to gauge design:
- in relation to MMC
- in relation to LMC
- in relation to RFS
- with respect to holes
- with respect to shafts

Describe positional tolerances to hole locations:
- bonus tolerance
- basic size
- assembly of two plates with floating fasteners
- assembly with a fixed and floating fastener

21.4 Interpret geometric drawing symbols. (2 hrs)

Interpret geometric engineering drawing symbols:
- location
- datum
- target
Number: S0622

Reportable Subject: METALLURGY

Duration: Total 6 hours  Theory 6 hours  Practical 0 hours

Prerequisites: L1 CC: S0601, S0602, S0603, S0604, S0605, S0606, S0607, S0608, S0609, S0610, S0611
L2: S0612, S0613, S0614, S0615, S0616, S0617, S0618, S0619

Content: S0622.1 Describe safe working procedures when working with heat-treating equipment.
S0622.2 Describe ferrous metal heat-treating processes. (4 hrs)
S0622.3 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

Mark Distribution:

<table>
<thead>
<tr>
<th>Theory Testing</th>
<th>Practical Application Testing</th>
<th>Final Assessment</th>
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<tbody>
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</table>

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

Reference Materials: Technology of Machine Tools
Shop Text Books
GENERAL LEARNING OUTCOMES

Upon successful completion the apprentice is able to describe ferrous heat-treating processes and the characteristics of non-metallic materials.

LEARNING OUTCOMES AND CONTENT

22.1 Describe safe working procedures associated with heat-treating furnaces and hand held equipment.

Describe heat-treating safety procedures and equipment including:
- protective clothing
- protective equipment and gear
- good housekeeping
- temperatures
- ventilation
- fire hazards
- storage and handling of equipment

Describe hand held heat-treating safety procedures including:
- protective clothing
- protective equipment and gear
- good housekeeping
- temperatures
- ventilation
- fire hazards
- storage and handling of equipment
22.2 Describe ferrous metal heat-treating processes. (4 hrs)

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

Describe the process and advantages of gas carburizing parts:
- types of gases
- hardness
- toughness
- strength
- type of furnace
- quenching media and procedures
- heat-treating specification
- machinability
- type of metal

Describe the process and advantages of liquid carburizing of steel:
- heat-treating specifications
- quenching media and procedures
- hardness
- toughness
- strength
- materials

Describe the process and advantages of induction hardening:
- heat-treating specifications
- type of metal
- depth of hardness
- frequency levels
- toughness
- strength
- quenching media and procedures
22.3 Describe the properties and characteristics of non-metallic materials. (2 hrs)

Describe the properties and characteristics of non-metallic materials:
- composites
- fiberglass
- carbon fiber
- plastics
- ceramics
- chemical
- physical
- mechanical
- optical
- shapes
- sizes
- tolerances
- surface conditions
- SPE code classifications
- heating response
- machinability
- applications
- surface finish
- fumes
Number: S0623

Reportable Subject: METROLOGY (MEASURING AND CHECKING)

Duration: Total 6 hours  Theory 3 hours  Practical 3 hours

Prerequisites: L1 CC: S0601, S0602, S0603, S0604, S0605, S0606, S0607, S0608, S0609, S0610, S0611
L2: S0612; S0613, S0614, S0615, S0616, S0617, S0618, S0619

Content:

S0623.1 Describe safe working procedures when setting up and operating measuring and checking equipment.

S0623.2 Describe the fundamentals of measuring, checking, and gauging equipment. (1 hr)

S0623.3 Describe the components, adjusting mechanisms, and working principles of an optical comparator. (1 hr)

S0623.4 Set up workholding devices and accessories for an optical comparator. (0.5 hrs)

S0623.5 Describe terminology and measuring techniques for an optical comparator. (0.5 hrs)

S0623.6 Demonstrate operational procedures for an optical comparator. (1 hr)

S0623.7 Demonstrate measuring and checking techniques using an optical comparator. (1 hr)

S0623.8 Describe the functions and operating principles of Coordinate Measuring Machines (CMM). (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

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GENERAL MACHINIST – LEVEL 3

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

Reference Materials: Technology of Machine Tools
Shop Text Books
GENERAL MACHINIST – LEVEL 3

S0623.0  Metrology (Measuring and Checking)

Duration:  Total 6 hours  Theory 3 hours  Practical 3 hours

Cross Reference to Training Standards:  GM U5231, U5232, U5233, U5233.11, U5235.16, U5236.11, U5237.20, U5238.14, U5239.15

GENERAL LEARNING OUTCOMES

Upon successful completion the apprentice is able to: demonstrate inspection and checking techniques using measuring and checking equipment; and, describe measuring and checking techniques using Optical Comparators and Coordinate Measuring Machines (CMM).

LEARNING OUTCOMES AND CONTENT

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

Identify potential safety hazards which may occur during the set-up and operating of measuring and checking equipment.

Demonstrate safe work habits including:

- protective clothing
- protective equipment and gear
- good housekeeping
- stabilizing workpieces
- operating procedures
- securing workpieces
- storage and handling of equipment
23.2 Describe the fundamentals of measuring, checking, and gauging equipment. (1 hr)

Describe measuring, checking, and gauging equipment:
- sine bar and sine plate
- compound sine plate
- precision cylindrical square
- precision level
- precision rollers
- precision balls
- tooling balls
- thread wires
- precision weight gauge
- plug gauges
- ring gauges
- snap gauges
- surface texture gauge
- square
- dial test gauges
- mechanical comparator
- optical flats
- gauge blocks
- optical comparators
- electrical comparator
- air gauges

23.3 Describe the components, adjusting mechanisms, and working principles of an optical comparator. (1 hr)

Describe parts of an optical comparator:
- illumination mechanism
- surface illumination
- table
- dials
- mylars
- screen
- micrometer dial
- read out
- angular settings/adjustments
- linear settings/adjustments
- locks
- magnification
- on/off
23.4 Set up workholding devices and accessories for an optical comparator.  
(0.5 hrs)

Identify workholding devices and attachments:
- vise
- Vee-block
- angle plates
- fixtures
- centres

Demonstrate mounting, positioning, aligning, and securing procedures.

23.5 Describe terminology and measuring techniques for an optical comparator.  
(0.5 hrs)

Describe terms used in optical comparator measurement techniques:
- accuracy
- precision
- tolerances
- reliability
- limits
- fits
- datums
- discrimination

Identify error sources in measurement and machine limitations:
- inherent instrument error
- observational error
- manipulative error
- bias error
- parallel error
- angular error
- profile illumination
23.6 Demonstrate operational procedures for an optical comparator. (1 hr)

Describe cleaning techniques of calibrated test specimen surfaces.

Identify features of workpiece to be checked.

Select indicating gauges and comparators by determining:
- type and applications
- component to be checked
- vibration errors
- accessibility to location
- predetermined values
- temperature variations
- graduating values
- checking ranges
- measuring ranges
- surface comparison
- magnification
- illumination of part profile/part surface

23.7 Demonstrate measuring and checking techniques using an optical comparator. (1 hr)

Demonstrate cleaning techniques of workpiece surfaces.

Describe geometric features to be measured and/or checked.

Demonstrate measurement and checking of geometric features.

Demonstrate inspection and recording techniques.

23.8 Describe the functions and operating principles of Coordinate Measuring Machines (CMM). (1 hr)

Describe cleaning techniques of workpiece surfaces.

Describe calibration/orientation techniques.

Identify features to be measured and/or checked.

Describe recording techniques.
Number: S0624

Reportable Subject: COMPLEX TURNING TECHNOLOGY

Duration: Total 42 hours Theory 10 hours Practical 32 hours

Prerequisites: L1 CC: S0601, S0602, S0603, S0604, S0605, S0606, S0607, S0608, S0609, S0610, S0611

L2: S0612, S0613, S0614, S0615, S0616, S0617, S0618, S0619

Content:
S0624.1 Describe safe working procedures when setting up and operating a lathe.
S0624.2 Describe lathe workholding devices, attachments, and accessories. (5.5 hrs)
S0624.3 Describe lathe cutting, trepanning, and forming tools, and tool holders. (6.5 hrs)
S0624.4 Develop a plan for lathe machining. (14 hrs)
S0624.5 Perform turning. (15 hrs)
S0624.6 Perform 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

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

Reference Materials:
Technology of Machine Tools
Shop Text Books
S0624.0  Complex Turning Technology

Duration:  Total 42 hours  Theory 10 hours  Practical 32 hours

Cross Reference to Training Standards:  GM U5230, U5231, U5232, U5237

GENERAL LEARNING OUTCOMES

Upon successful completion the apprentice is able to demonstrate: turning of internal or external tapers and angles using a taper turning attaching; turning of internal or external tapers and angles using a compound rest; turning of profiles; cutting ACME threads and multiple start threads; and describe sharpening of cutting tools.

LEARNING OUTCOMES AND CONTENT

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

Identify potential safety hazards which may occur during lathe set-up and operating procedures.

Demonstrate safe working habits including:

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

24.2 Describe lathe workholding devices, attachments, and accessories. (5.5 hrs)

Describe lathe workholding devices, attachments, and accessories:

- face plates
- mandrel and split
- steady rest
- follower rest
- fixture
- soft jaw chucks
- radius attachment
- bungs and spigots
- tool post grinder
- tracing attachment
24.3 Describe lathe cutting, trepanning, and forming tools, and tool holders. *(6.5 hrs)*

Identify tool geometry for lathe cutting tools.

Describe lathe-cutting tools:
- form threading tool
- trepanning tools
- forming tools

Identify lathe cutting, trepanning, and forming tools and tool holders by determining:
- type
- shape
- size
- angle
- cutting tool geometry
- cutting capacity
- function
- holding characteristics
- mounting characteristics
- cutting characteristics
- shaping characteristics
- alignment
- tolerances
- surface finish
- chip development and flow
- workpiece characteristics

Describe mounting, positioning, alignment, and securing procedures.

Describe tool post grinding.

24.4 Develop a plan for lathe machining. *(14 hrs)*

Interpret drawings and/or process sheets to identify:
- workpiece material
- number of workpieces
- form
- shape of workpiece
- machining operations
- tolerances
- surface finish
- machining sequence
24.4 Continued

Select lathe machining procedures:
- profile turning
- tool post grinding
- ACME thread cutting

Identify machining operations and procedures for profile turning or tool post grinding:
- operating principles
- rough cutting
- finish cutting
- surface finish
- tolerances
- speeds
- feeds
- coolant requirements
- mounting of tool
- positioning of tool
- securing of tool
- cutting capacity of lathe

Identify measuring and checking procedures.

24.5 Perform turning. (15 hrs)

Demonstrate turning of internal and external tapers or angles using a taper turning attachment.

Demonstrate turning of external and internal tapers or angles using a compound rest.

Demonstrate the cutting of ACME threads.

Demonstrate turning of profiles.

Demonstrate sharpening of cutting tools.

Demonstrate cutting of multiple start threads.
24.6 Perform routine maintenance. *(1 hr)*

- Demonstrate routine maintenance and cleaning procedures.
- Demonstrate lubrication procedures.
- Demonstrate dismantling, handling, and storage of tools, tooling, workholding devices, and measuring instruments.
GENERAL MACHINIST – LEVEL 3

Number: S0625

Reportable Subject: COMPLEX MILLING TECHNOLOGY

Duration: Total 42 hours Theory 10 hours Practical 32 hours

Prerequisites: L1 CC: S0601, S0602, S0603, S0604, S0605, S0606, S0607, S0608, S0609, S0610, S0611
L2: S0612; S0613, S0614, S0615, S0616, S0617, S0618, S0619

Content: S0625.1 Describe safe working procedures when setting up and operating milling machines.
S0625.2 Identify milling attachments used for complex milling operations. (3 hrs)
S0625.3 Develop a plan for complex milling operations. (2 hrs)
S0625.4 Describe procedures for using mill workholding devices and accessories. (3 hrs)
S0625.5 Describe the assembly of cutting tools and tool holders for complex milling operations. (2 hrs)
S0625.6 Demonstrate complex milling operations. (31 hrs)
S0625.7 Perform 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

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

Reference Materials: Technology of Machine Tools
Shop Text Books
S0625.0 Complex Milling Technology

Duration: Total 42 hours  Theory 10 hours  Practical 32 hours

Cross Reference to Training Standards: GM U5230, U5231, U5232, U5238

GENERAL LEARNING OUTCOMES

Upon successful completion the apprentice is able to demonstrate milling of complex geometric shapes.

LEARNING OUTCOMES AND CONTENT

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

Identify potential safety hazards which may occur during milling set-up and operating procedures.

Demonstrate safe working habits including:
- protective clothing
- protective equipment and gear
- good housekeeping
- start up and shut off procedures
- securing and stabilizing of workpiece
- lock out procedures
- use of lifting devices

25.2 Identify milling attachments used for complex milling operations. (3 hrs)

Identify attachments used for complex milling operations:
- slotting head
- right angle attachment
- vertical/horizontal attachment
- high speed attachment
- boring/facing heads
- swivel attachments
- dividing heads
25.3 Develop a plan for complex milling operations. (2 hrs)

Interpret engineering drawings, CAD data, or process sheets to determine:
- workpiece material
- number of workpieces
- form and shape of workpiece
- machining operations
- tolerances
- surface finish
- machining sequences

Identify complex milling techniques:
- gear cutting
- helical milling
- line boring
- back boring
- cam milling (CNC application)

Identify workholding devices by determining:
- application
- operating principles
- graduation values
- angular and rotation settings
- workpiece characteristics
- positioning, mounting and securing procedures
- discrimination

Identify required cutting tools, tool holding devices, and accessories by determining:
- type and application
- clearances
- tolerances
- surface finish
- machining operations and sequences
- cutting fluid requirements
- operating principles
- toolholding and support requirements
- speed and feed values
- workpiece characteristics
- handling, storing, and maintenance procedures

Describe measuring and checking procedures.
25.4 Describe procedures for using mill workholding devices and accessories. (3 hrs)

Identify mill workholding devices:
- dividing head
- mandrels
- rotary table

Describe workholding device set-up procedures by determining:
- application
- operating principles
- type
- size
- function
- tool selection
- type of tool
- workpiece features
- holding characteristics
- mounting characteristics
- location accessibility
- workpiece characteristics
- handling procedures
- storing procedures
- maintenance procedures

Describe contact surface cleaning procedures.

Demonstrate mounting, positioning, aligning, and securing procedures.

25.5 Describe the assembly of cutting tools and holders for complex milling operations. (2 hrs)

Identify cutting tool geometry (nomenclature).

Describe milling cutting tools and tool holders:
- gear cutters
- solid carbide
- boring tools
- boring and facing heads
25.5 Continued

Describe required cutting tools and tool holders by determining:
- type and size
- cutting tool material
- shape
- application
- holding/mounting characteristics
- cutting and shaping characteristics
- tolerances
- surface finish

Demonstrate the assembly of cutting tools and holders.

25.6 Demonstrate complex milling operations. (31 hrs)

Describe helical milling techniques.

Describe cam milling techniques.

Demonstrate the milling of complex geometric shapes.

25.7 Perform routine maintenance. (1 hr)

Describe routine maintenance and cleaning procedures.

Describe lubrication procedures.

Describe dismantling, handling, and storage of tools, tooling, workholding devices, and measuring equipment.
GENERAL MACHINIST – LEVEL 3

Number: S0626

Reportable Subject: COMPLEX GRINDING TECHNOLOGY

Duration: Total 18 hours Theory 6 hours Practical 12 hours

Prerequisites: L1 CC: S0601, S0602, S0603, S0604, S0605, S0606, S0607, S0608, S0609, S0610, S0611
L2: S0612, S0613, S0614, S0615, S0616, S0617, S0618, S0619

Content:

S0626.1 Describe safe working procedures when setting up and operating grinders.
S0626.2 Describe internal grinding techniques and processes. (1.5 hrs)
S0626.3 Identify workholding devices or attachments used for internal grinding. (1.5 hrs)
S0626.4 Describe grinding wheels used for internal grinding and sharpening of end mills. (2 hrs)
S0626.5 Develop a plan for internal grinding and sharpening of end mills. (2 hrs)
S0626.6 Demonstrate internal grinding and end mill sharpening. (10 hrs)
S0626.7 Perform 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

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Instructional and Delivery Strategies:

Lecture
Video
Paper based material
CBT
Internet On-Line

Reference Materials:

Technology of Machine Tools
Shop Text Books

- 31 -
GENERAL MACHINIST – LEVEL 3

S0626.0 Complex Grinding Technology

Duration: Total 18 hours  Theory 6 hours  Practical 12 hours

Cross Reference to Training Standards:  GM U5230, U5231, U5232, U5236

GENERAL LEARNING OUTCOMES

Upon successful completion the apprentice is able to perform end mill sharpening and internal grinding.

LEARNING OUTCOMES AND CONTENT

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

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

Demonstrate safe working habits including:
• protective clothing and equipment
• good housekeeping
• start up and shut off procedures
• securing and stabilizing of workpiece
• guards and dust extraction system
• dressing and inspection of grinding wheel
• lock out procedure
• maximum wheel RPM
• ring test of wheel

26.2 Describe internal grinding techniques and processes. (1.5 hrs)

Identify machining processes and components of plain or universal cylindrical grinders:
• universal cylindrical grinding
• tool post grinding
• tool and cutter grinder
• I/D grinder
• jig grinder

Describe cutting fluid applications.
26.3 Identify workholding devices and/or attachments used for internal grinding. (1.5 hrs)

Describe workholding devices, accessories, and attachments used in internal grinding techniques:
- wheel dressing attachment
- radius and tangent wheel dresser
- angular wheel dresser
- radius dresser
- three-jaw chuck
- four-jaw chuck
- magnetic chuck
- collets chuck
- crush roll forming
- steady rest
- arbors
- universal work-head
- internal grinding attachment

26.4 Describe grinding wheels used for internal grinding and sharpening of end mills. (2 hrs)

Identify grinding wheels:
- straight
- recessed
- cup
- dished
- flared
- cut-off
- mounted

Describe mounting, truing, and dressing of grinding wheels.

Identify cutting tool geometry on an end mill by determining:
- land
- heel
- flutes
- helix angle
- rake angle
- tooth face
- peripheral cutting edge
- relief angles (clearance)
- peripheral and end face clearance angles
26.5 Develop a plan for internal grinding and sharpening of end mills. *(2 hrs)*

Interpret drawings, CAD data or process sheets to determine:
- workpiece material characteristics
- form and shape of workpiece
- surface finish
- tolerance
- machining operations and sequences

Identify grinding techniques:
- plunge grinding
- I/D grinding
- profile grinding
- parallel grinding
- internal taper grinding
- centre gashing
- form grinding
- cut off grinding
- grinding primary and secondary angles

Identify workholding devices and/or attachments:
- tooth rest and support
- centre height gauge
- wheel dressing attachment
- collets chuck

26.6 Demonstrate internal grinding and end mill sharpening. *(10 hrs)*

Demonstrate end mill sharpening.

Demonstrate internal grinding.

26.7 Perform routine maintenance. *(1 hr)*

Demonstrate routine maintenance and cleaning procedures.

Demonstrate lubrication procedures.

Demonstrate dismantling, handling, and storage of tools, tooling and workholding devices, and measuring equipment.
Number: S0627

Reportable Subject: MACHINING CENTRE CNC TECHNOLOGY

Duration: Total 48 hours Theory 24 hours Practical 24 hours

Prerequisites: L1 CC: S0601, S0602, S0603, S0604, S0605, S0606, S0607, S0608, S0609, S0610, S0611
L2: S0612; S0613, S0614, S0615, S0616, S0617, S0618, S0619

Content:

S0627.1 Describe safe working procedures when setting up and operating CNC machining centres.
S0627.2 Describe operating principles of CNC machining centres. (2 hrs)
S0627.3 Describe use of job documentation to determine job requirements. (2 hrs)
S0627.4 Describe the application of machining centres. (2 hrs)
S0627.5 Describe machining centre operations. (2 hrs)
S0627.6 Describe manual operating systems for CNC machining centres. (3 hrs)
S0627.7 Describe circular interpolation on a machining centre. (2 hrs)
S0627.8 Develop a plan for CNC machining centres. (10 hrs)
S0627.9 Describe the setting up and application of workholding devices for CNC machining centre operations. (10 hrs)
S0627.10 Demonstrate procedures for entering and verifying programs for a CNC machining centre to perform linear and circular machining operations. (15 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

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GENERAL MACHINIST – LEVEL 3

Instructional and Delivery Strategies:  
Lecture  
Video  
Paper based material  
CBT

Reference Materials:  
Technology of Machine Tools  
Shop Text Books
GENERAL MACHINIST – LEVEL 3

S0627.0  Machining Centre CNC Technology

Duration:  Total 48 hours  Theory 24 hours  Practical 24 hours

Cross Reference to Training Standards:  GM  U5230, U5231, U5232, U5239

GENERAL LEARNING OUTCOMES

Upon successful completion the apprentice is able to describe numerically controlled machining centres techniques and demonstrate procedures for entering and verifying a program to perform linear and circular machining operations.

LEARNING OUTCOMES AND CONTENT

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

Identify potential safety hazards which may occur during CNC machine set-up and operating procedures.

Demonstrate safe working habits including:

• protective clothing
• protective equipment and gear
• good housekeeping
• start-up procedures
• shut-off procedures
• securing workplace/cutting tools
• stabilizing workplace/cutting tools
• lubricants
• fire protection
27.2 Describe operating principles of CNC machining centres. (2 hrs)

Identify the capabilities, operating principles, and controls of CNC machining centres:

- types of equipment
- editing capability
- program path ability
- processing power
- high speed machining
- CNC controls
- tapeless controls
- PC/DNC systems

Describe the major features and functions of CNC machining centres and the manufacturing process:

- CPU
- input devices
- work envelope
- tool changer
- holding devices
- safety interlock
- 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

27.3 Describe use of job documentation to determine job requirements. (2 hrs)

Identify job documentation required to complete the job.

Develop job set-up sheets by identifying:

- axis alignment
- locating points
- workholding methods
- program zero
27.3 Continued

Develop tooling list by identifying:

- tools
- tool holders
- type of tool material
- set-up dimensions
- tool numbers
- tool offsets
- cutter radius compensation register
- workpiece materials

27.4 Describe the application of machining centres. (2 hrs)

Describe the methodology of programming parts as opposed to conventional machining:

- differential
- cam
- helical
- thread

27.5 Describe machining centre operations. (2 hrs)

Describe fixed cycles:

- centre drilling
- drilling
- counterboring
- reaming
- tapping

Describe fixed cycle terms and sequences:

- initial level
- R point level
- Z level
- machining increment
- rapid approach
- rapid retract
- dwell time
- feed rate directions

Describe the advanced additional specialized CNC techniques:

- HSM
- thread milling
- live tooling
- 4th and 5th axis
27.6 Describe manual operating systems for CNC machining centres. (3 hrs)

Describe manual interruption on a machining centre:
- single block operation
- feedhold
- emergency stop

Describe manual data input (MDI) on a machining centre:
- 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

27.7 Describe circular interpolation on a machining centre. (2 hrs)

Describe circular interpolation planes:
- X - Y plane
- Z - X plane
- Y - Z plane
- arc centre modifiers

Describe circular interpolation commands:
- arc modifiers
- radius
- quadrants
- circles
- cutter radius compensation
27.8 Develop a plan for CNC machining centres. \textbf{(10 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

27.9 Describe the setting up and application of workholding devices for CNC machining centre operations. \textbf{(10 hrs)}

Describe the setting up of a vise or fixture on a machining centre:

- alignment to axis
- locators for multiple parts
- clamping pressures
- establish program zero
- part geometry considerations

Describe the use of dimensioning practices:

- raw stock pre-machining
- pre-machining
- castings
- locating points
- clamping areas
- multiple parts
- fixture offsets
- quantity of parts

27.10 Demonstrate procedures for entering and verifying programs for a CNC machining centre to perform linear and circular machining operations. \textbf{(15 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
27.10 Continued

Demonstrate the use of codes to specify word and block structures:
- program identification
- block number
- N-word
- starting number
- increments
- end of block
- block description
- status block (safe block)
- message block (program comments)
- conflicting words
- modal programming values
- execution priority

Demonstrate the use of codes to specify dimensions:
- metric/inch selection
- absolute/incremental selection
- absolute data input
- incremental data input
- syntax
- zero suppression and decimal point
- leading and trailing zeros input

Demonstrate the use of codes to specify:
- tool number
- tool length offset
- tool radius offset

Demonstrate the use of codes to invoke speeds and feeds:
- spindle function
- S-code
- spindle rotation direction
- spindle stop
- spindle orientation
- spindle speed (RPM)
- feedrate control
- feedrate function
- feedrate per minute
- feedrate override and feedhold
- feedrate override and functions
27.10 Continued

Demonstrate the use of codes to establish reference points:
- machine reference point
- manufacturers’ setting
- workpiece reference point
- program zero application
- position register command
- fixture offsets

Demonstrate the use of codes to execute rapid positioning:
- rapid traverse motion
- positioning mode
- tool path
- workpiece approach
- single axis motion
- multi-axis motion
- straight angular motion
- type of motion and time comparison
- rapid motion path
- axis motion completion

Demonstrate use of codes to establish zero return commands:
- zero return commands
- return to machine zero

Demonstrate the use of codes to create contouring programs:
- cutter path determination
- linear interpolation
- circular interpolation
- rough and finished shape
- helical circular interpolation

Describe cutter radius compensation:
- compensation right
- compensation left
- radius offset table
- radius wear offset
- radius setting

Demonstrate procedures to enter and verify a program to mill a workpiece that includes drilling and profiling.
27.10 Continued

Demonstrate downloading of a program that includes:

- feeds
- speeds
- overrides
- axis selection
- mode selection