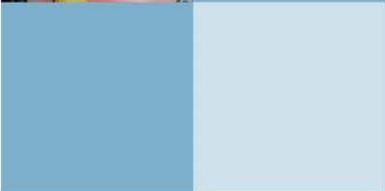


# PROGRAM OUTLINE

## Machinist





The latest version of this document is available in PDF format on the ITA website  
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# **MACHINIST PROGRAM OUTLINE**

**APPROVED BY INDUSTRY  
JUNE 2014**

**BASED ON  
NOA 2013**

**Developed by  
Industry Training Authority  
Province of British Columbia**



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# **Section 1**

# **INTRODUCTION**

# **Machinist**



## Foreword

### 2014

The Program Standards for Machinist 2014 were updated through a Standards Review project funded by the Industry Training Authority.

These revised standards incorporate changes made to the National Occupational Analysis Machinist released in 2013. The standards were reviewed and adjusted by a group of Subject Matter Experts (SMEs), during a one day workshop in June 2014. Thanks are extended to SMEs for their dedication and participation in keeping Machinist Program Standards technologically current and aligned with the needs of industry.

### 2008

The Program Standards for Machinist 2008 were updated through a Standards Review project funded by the Industry Training Authority.

The work was coordinated by a joint management / labour committee that included representation from a broad cross section of employers of Machinists, labour representatives and representatives from BC's post-secondary system. These revised standards incorporate changes made to the National Occupational Analysis (Machinist) released in 2005.

The standards were reviewed and adjusted by a group of Subject Matter Experts (SMEs), all Machinists. The SME group met for two days in September 2008, and for three additional days in December 2008. The SMEs were drawn from a wide cross section of industry and thanks are extended to them for their dedication and participation in keeping Machinist Program Standards technologically current and aligned with the needs of industry.

#### **SAFETY ADVISORY**

Be advised that references to the WorkSafeBC safety regulations contained within these materials do not/may not reflect the most recent Occupational Health and Safety Regulation (the current Standards and Regulation in BC can be obtained on the following website: <http://www.worksafebc.com>). Please note that it is always the responsibility of any person using these materials to inform him/herself about the Occupational Health and Safety Regulation pertaining to his/her work.



## Acknowledgements

### **Subject Matter Experts retained to assist with the review and update of the Program Outline (2014):**

- James Cai BC Institute of Technology
- Dave Sanford Howe Sound Pulp and Paper (retired)
- David Peare Patton and Cooke
- Ron Metcalfe Murrey Latta Progressive Machine
- Daniel Smith Howe Sound Pulp and Paper

### **Facilitators (2014)**

- Angela Caughy RTO (Resource Training Organization)
- Leslie Marining RTO (Resource Training Organization)

The Industry Training Authority would like to acknowledge the dedication and hard work of all the industry and training provider representatives appointed to identify the training requirements of the Machinist occupation.



## How to Use this Document

This Program Outline has been developed for the use of individuals from several different audiences. The table below describes how each section can be used by each intended audience.

Section	Training Providers	Employers/ Sponsors	Apprentices	Challengers
<b>Program Credentialing Model</b>	Communicate program length and structure, and all pathways to completion	Understand the length and structure of the program	Understand the length and structure of the program, and pathway to completion	Understand challenger pathway to Certificate of Qualification
<b>OAC</b>	Communicate the competencies that industry has defined as representing the scope of the occupation	Understand the competencies that an apprentice is expected to demonstrate in order to achieve certification	View the competencies they will achieve as a result of program completion	Understand the competencies they must demonstrate in order to challenge the program
<b>Training Topics and Suggested Time Allocation</b>	Shows proportionate representation of general areas of competency (GACs) at each program level, the suggested proportion of time spent on each GAC, and percentage of time spent on theory versus practical application	Understand the scope of competencies covered in the technical training, the suggested proportion of time spent on each GAC, and the percentage of that time spent on theory versus practical application	Understand the scope of competencies covered in the technical training, the suggested proportion of time spent on each GAC, and the percentage of that time spent on theory versus practical application	
<b>Program Content</b>	Defines the objectives, learning tasks, high level content that must be covered for each competency, as well as defining observable, measurable achievement criteria for objectives with a practical component	Identifies detailed program content and performance expectations for competencies with a practical component; may be used as a checklist prior to signing a recommendation for certification (RFC) for an apprentice	Provides detailed information on program content and performance expectations for demonstrating competency	Allows individual to check program content areas against their own knowledge and performance expectations against their own skill levels





Section	Training Providers	Employers/ Sponsors	Apprentices	Challengers
<b>Training Provider Standards</b>	Defines the facility requirements, tools and equipment, reference materials (if any) and instructor requirements for the program	Identifies the tools and equipment an apprentice is expected to have access to; which are supplied by the training provider and which the student is expected to own	Provides information on the training facility, tools and equipment provided by the school and the student, reference materials they may be expected to acquire, and minimum qualification levels of program instructors	Identifies the tools and equipment a tradesperson is expected to be competent in using or operating; which may be used or provided in a practical assessment
<b>Appendix-Assessment Guidelines</b>	Identifies the percentage weight of theory and practical assessment in technical training		Identifies the percentage weight of theory and practical assessment in technical training	
<b>Appendix-Glossary of Acronyms</b>			Defines program specific acronyms	Defines program specific acronyms
<b>Appendix-Previous Contributors</b>	Provides information on previous contributors to the Program Outline review	Provides information on previous contributors to the Program Outline review	Provides information on previous contributors to the Program Outline review	Provides information on previous contributors to the Program Outline review



# **Section 2**

# **PROGRAM CONTENT**

# **Machinist**

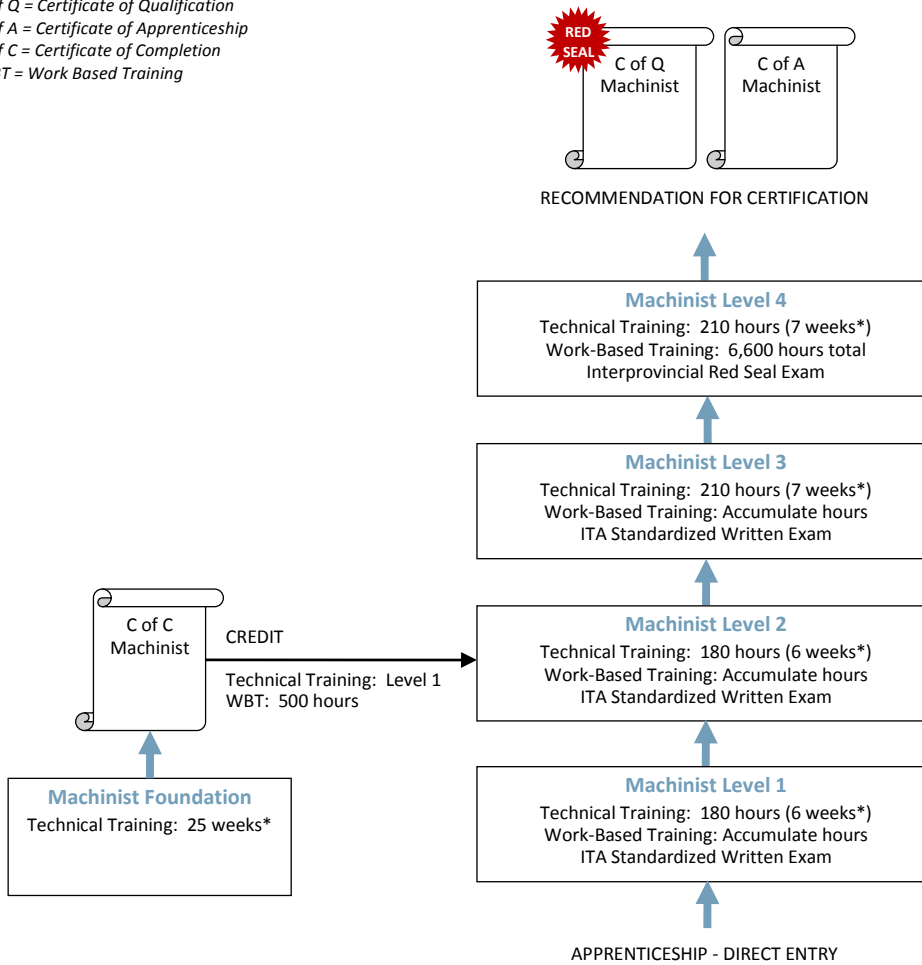


## Program Credentialing Model

### Apprenticeship Pathway

This graphic provides an overview of the Machinist apprenticeship pathway.

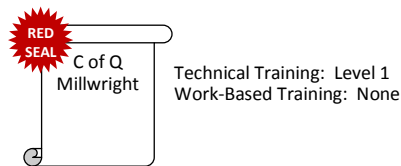
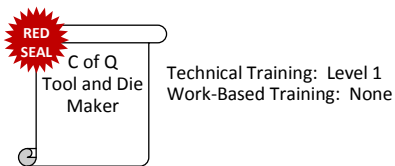
C of Q = Certificate of Qualification  
 C of A = Certificate of Apprenticeship  
 C of C = Certificate of Completion  
 WBT = Work Based Training



\*Suggested duration based on 30-hour week

**CROSS-PROGRAM CREDITS**

Individuals who hold the credentials listed below are entitled to receive partial credit toward the completion requirements of this program

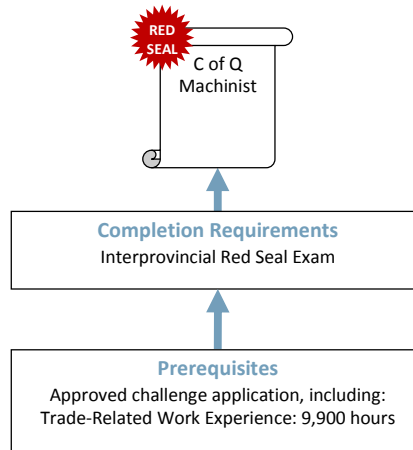




## Challenge Pathway

This graphic provides an overview of the Machinist challenge pathway.

*C of Q = Certificate of Qualification*




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### CREDIT FOR PRIOR LEARNING

*Individuals who hold the credentials listed below are considered to have met or partially met the prerequisites for challenging this program*

Military certificate in Marine Engineering Technician (MT #313 QL5 or higher)	Work Experience: 9,900 hours
--	------------------------------



## Occupational Analysis Chart

### MACHINIST

**Occupation Description:** A machinist is someone who turns blocks of metal into complex, intricate metal parts for other products. They fit and assemble metal parts and sub-assemblies, ensuring the parts in these products meet exacting standards in size, strength and hardness.

<b>Use Safe Work Practices</b> <b>A</b>	Describe Occupational Health and Safety Regulations A1 1	Describe WHMIS and Hazardous Materials Safety (HAZMAT) A2 1	Apply safety practices for shop areas A3 1	Use lifting equipment A4 1		
	<b>Use Hand Tools</b> <b>B</b>	Use and maintain hand tools B1 1	Use layout tools B2 1	Use and maintain handheld power tools B3 1	Mark workpieces for identification B4 1	
<b>Use Applied Mathematics</b> <b>C</b>		Solve problems involving formulas C1 1   2	Solve problems involving ratios C2 1     3	Perform metric / imperial conversions C3 1	Solve problems involving geometry C4 1	Solve problems involving algebra C5 1
	Solve problems involving trigonometry C7 1   2   3					
	<b>Use Measuring Tools</b> <b>D</b>	Use linear and Vernier scales D1 1	Use micrometers D2 1	Use callipers and gauges D3 1   2   3	Use dial indicators and digital readouts D4 1   2   3	Describe optical measuring equipment A5         4



**Interpret Drawings and Reference Materials**  
E

Interpret information found on drawings  
E1  
1 | | | | |

Sketch machined parts  
E2  
1 | | | | |

Use Machinery's Handbook and other reference materials  
E3  
1 | 2 | 3 | 4 | |

Describe fits and tolerances  
E4  
1 | 2 | | | |

**Select Materials**  
F

Describe principles of metallurgy  
F1  
| 2 | | 4 | |

Describe characteristics of ferrous metals  
F2  
| 2 | 3 | 4 | |

Describe characteristics of non-ferrous metals  
F3  
| 2 | 3 | 4 | |

Describe characteristics of non-metals  
F4  
| 2 | 3 | 4 | |

Select materials for applications  
F5  
| | | 3 | | |

Describe and perform heat treating  
F6  
| | | 3 | 4 | |

Describe materials testing  
F7  
| | | 3 | 4 | |

Describe the use and maintenance of fuel gas equipment  
F8  
| 2 | | | | |

**Plan Sequence of Operation**  
G

Determine project requirements  
G1  
1 | 2 | 3 | 4 | |

Describe work holding devices  
G2  
1 | | | | |

Perform roughing and finishing  
G3  
1 | | | 4 | |

**Describe Fabrication and Assembly**  
H

Identify fasteners  
H1  
1 | | | | |

Identify lubricants and sealants  
H2  
1 | | | | |

Describe bearings, seals and bearing materials  
H3  
| | | 3 | | |

Disassemble and assemble components  
H4  
| | | 3 | | |

**Use Drilling Machines**  
I

Describe drilling machines  
I1  
1 | | | | |

Select and maintain cutting tools  
I2  
1 | | | | |

Operate and maintain drilling machines  
I3  
1 | | | | |



<b>Use Power Saws</b> <b>J</b>	Describe power saws J1	Select and maintain band saw blades J2	Operate and maintain band saws J3	Operate and maintain other saws J4	
	1	1	1	1	
<b>Use Lathes</b> <b>K</b>	Describe lathes K1	Operate and maintain lathes K2	Cut tapers K3	Cut threads K4	Describe the use of advanced cutting tools K5
	1	1	1	2   3	2
<b>Use Milling Machines</b> <b>L</b>	Describe milling machines L1	Describe cutting tools and holders L2	Use dividing heads and rotary tables L3	Operate and maintain milling machines L4	
	2	2	2   3	2   3	
<b>Use Support Machines</b> <b>M</b>	Operate and maintain hydraulic and arbour presses M1	Operate and maintain hones and lapping machines M2	Operate and maintain gear cutting and electrical discharge machines M3		
	1	3	1		
<b>Use Grinders and Abrasives</b> <b>N</b>	Describe types of grinders N1	Select abrasives N2	Operate and maintain grinders N3	Operate and maintain sanders and polishers N4	
	1     3	1   2   3	1       3	1	
<b>Use Boring Mills</b> <b>O</b>	Describe boring mills O1	Operate and maintain vertical boring mills O2	Operate and maintain horizontal boring mills O3		
	3   4	3	4		



<b>Use C.N.C. Machines</b>  <b>P</b>	Describe C.N.C. machines  P1	Describe co-ordinate systems and programming codes  P2	Operate and maintain C.N.C. machines  P3
	4	4	4





## Training Topics and Suggested Time Allocation

Training Topics and Suggested Time Allocation shows the proportionate representation of general areas of competency (GACs) at each program level, the suggested proportion of time spent on each GAC, and percentage of time spent on theory versus practical application

### MACHINIST – LEVEL 1

		% of Time Allocated to:			
		% of Time	Theory	Practical	Total
<b>Line A</b>	<b>Use Safe Work Practices</b>	<b>14%</b>	<b>80%</b>	<b>20%</b>	<b>100%</b>
A1	Describe Occupational Health and Safety Regulations		✓		
A2	Describe WHMIS and Hazardous Materials Safety (HAZMAT)		✓		
A3	Apply safety practices for shop areas		✓	✓	
A4	Use lifting equipment		✓	✓	
<b>Line B</b>	<b>Use Hand Tools</b>	<b>9%</b>	<b>50%</b>	<b>50%</b>	<b>100%</b>
B1	Use and maintain hand tools		✓	✓	
B2	Use layout tools		✓	✓	
B3	Use and maintain handheld power tools		✓	✓	
B4	Mark workpieces for identification		✓	✓	
<b>Line C</b>	<b>Use Applied Mathematics</b>	<b>10%</b>	<b>100%</b>	<b>0%</b>	<b>100%</b>
C1	Solve problems involving formulas		✓		
C2	Solve problems involving ratios		✓		
C3	Perform metric / imperial conversions		✓		
C4	Solve problems involving geometry		✓		
C5	Solve problems involving algebra		✓		
C6	Solve problems involving mass, area and volume		✓		
C7	Solve problems involving trigonometry		✓		
<b>Line D</b>	<b>Use Measuring Tools</b>	<b>9%</b>	<b>50%</b>	<b>50%</b>	<b>100%</b>
D1	Use linear and vernier scales		✓	✓	
D2	Use micrometers		✓	✓	
D3	Use callipers and gauges		✓	✓	
D4	Use dial indicators and digital readouts		✓	✓	
<b>Line E</b>	<b>Interpret Drawings and Reference Materials</b>	<b>8%</b>	<b>80%</b>	<b>20%</b>	<b>100%</b>
E1	Interpret information found on drawings		✓	✓	
E2	Sketch machined parts		✓	✓	
E3	Use Machinery's Handbook and other reference materials		✓	✓	
E4	Describe fits and tolerances		✓	✓	
<b>Line G</b>	<b>Plan Sequence of Operation</b>	<b>7%</b>	<b>50%</b>	<b>50%</b>	<b>100%</b>
G1	Determine project requirements		✓	✓	
G2	Describe work holding devices		✓	✓	
G3	Perform roughing and finishing		✓	✓	



% of Time Allocated to:

		% of Time	Theory	Practical	Total
<b>Line H</b>	<b>Describe Fabrication and Assembly</b>	<b>6%</b>	<b>100%</b>	<b>0%</b>	<b>100%</b>
H1	Identify fasteners		✓		
H2	Identify lubricants and sealants		✓		
<b>Line I</b>	<b>Use Drilling Machines</b>	<b>9%</b>	<b>50%</b>	<b>50%</b>	<b>100%</b>
I1	Describe drilling machines		✓		
I2	Select and maintain cutting tools		✓	✓	
I3	Operate and maintain drilling machines		✓	✓	
<b>Line J</b>	<b>Use Power Saws</b>	<b>6%</b>	<b>80%</b>	<b>20%</b>	<b>100%</b>
J1	Describe Power Saws		✓		
J2	Select and maintain band saw blades		✓	✓	
J3	Operate and maintain band saws		✓	✓	
J4	Operate and maintain other saws		✓		
<b>Line K</b>	<b>Use Lathes</b>	<b>11%</b>	<b>50%</b>	<b>50%</b>	<b>100%</b>
K1	Describe lathes		✓		
K2	Operate and maintain lathes		✓	✓	
K3	Cut tapers		✓	✓	
<b>Line M</b>	<b>Use Support Machines</b>	<b>5%</b>	<b>80%</b>	<b>20%</b>	<b>100%</b>
M1	Operate and maintain hydraulic and arbour presses		✓	✓	
<b>Line N</b>	<b>Use Grinders and Abrasives</b>	<b>6%</b>	<b>50%</b>	<b>50%</b>	<b>100%</b>
N1	Describe types of grinders		✓		
N2	Select abrasives		✓	✓	
N3	Operate and maintain grinders			✓	
N4	Operate and maintain sanders and polishers			✓	
<b>Total Percentage for Machinist Level 1</b>		<b>100%</b>			



## Training Topics and Suggested Time Allocation

### MACHINIST – LEVEL 2

		% of Time Allocated to:			
		% of Time	Theory	Practical	Total
<b>Line C</b>	<b>Use Applied Mathematics</b>	<b>12%</b>	<b>100%</b>	<b>0%</b>	<b>100%</b>
C1	Solve problems involving formulas		✓		
C7	Solve problems involving trigonometry		✓		
<b>Line D</b>	<b>Use Measuring Tools</b>	<b>10%</b>	<b>50%</b>	<b>50%</b>	<b>100%</b>
D3	Use callipers and gauges		✓	✓	
D4	Use dial indicators and digital readouts		✓	✓	
<b>Line E</b>	<b>Interpret Drawings and Reference Materials</b>	<b>11%</b>	<b>100%</b>	<b>0%</b>	<b>100%</b>
E3	Use Machinery's Handbook and other reference materials		✓		
E4	Describe fits and tolerances		✓		
<b>Line F</b>	<b>Select Materials</b>	<b>10%</b>	<b>100%</b>	<b>0%</b>	<b>100%</b>
F1	Describe principles of metallurgy		✓		
F2	Describe characteristics of ferrous metals		✓		
F3	Describe characteristics of non-ferrous metals		✓		
F4	Describe characteristics of non-metals		✓		
F8	Describe the use and maintenance of fuel gas equipment		✓		
<b>Line G</b>	<b>Plan Sequence of Operation</b>	<b>10%</b>	<b>50%</b>	<b>50%</b>	<b>100%</b>
G1	Determine project requirements		✓	✓	
<b>Line K</b>	<b>Use Lathes</b>	<b>19%</b>	<b>50%</b>	<b>50%</b>	<b>100%</b>
K4	Cut threads		✓	✓	
K5	Describe the use of advanced cutting tools		✓		
<b>Line L</b>	<b>Use Milling Machines</b>	<b>21%</b>	<b>50%</b>	<b>50%</b>	<b>100%</b>
L1	Describe milling machines		✓		
L2	Describe cutting tools and holders		✓		
L3	Use dividing heads and rotary tables		✓	✓	
L4	Operate and maintain milling machines			✓	
<b>Line N</b>	<b>Use Grinders and Abrasives</b>	<b>7%</b>	<b>100%</b>	<b>0%</b>	<b>100%</b>
N2	Select abrasives		✓		
<b>Total Percentage for Machinist Level 2</b>		<b>100%</b>			



## Training Topics and Suggested Time Allocation

### MACHINIST – LEVEL 3

		% of Time Allocated to:			
		% of Time	Theory	Practical	Total
<b>Line C</b>	<b>Use Applied Mathematics</b>	9%	100%	0%	100%
C2	Solve problems involving ratios		✓		
C7	Solve problems involving trigonometry		✓		
<b>Line D</b>	<b>Use Measuring Tools</b>	5%	50%	50%	100%
D3	Use callipers and gauges		✓	✓	
D4	Use dial indicators and digital readouts		✓	✓	
<b>Line E</b>	<b>Interpret Drawings and Reference Materials</b>	7%	50%	50%	100%
E3	Use Machinery's Handbook and other reference materials		✓	✓	
<b>Line F</b>	<b>Select Materials</b>	7%	80%	20%	100%
F2	Describe characteristics of ferrous metals		✓		
F3	Describe characteristics of non-ferrous metals		✓		
F4	Describe characteristics of non-metals		✓		
F5	Select materials for applications		✓	✓	
F6	Describe and perform heat treating		✓	✓	
F7	Describe materials testing		✓	✓	
<b>Line G</b>	<b>Plan Sequence of Operation</b>	5%	50%	50%	100%
G1	Determine project requirements		✓	✓	
<b>Line H</b>	<b>Describe Fabrication and Assembly</b>	5%	80%	20%	100%
H3	Describe bearings, seals and bearing materials		✓		
H4	Disassemble and assemble components			✓	
<b>Line K</b>	<b>Use Lathes</b>	18%	50%	50%	100%
K4	Cut threads		✓	✓	
<b>Line L</b>	<b>Use Milling Machines</b>	25%	50%	50%	100%
L3	Use dividing heads and rotary tables		✓	✓	
L4	Operate and maintain milling machines		✓	✓	
<b>Line M</b>	<b>Use Support Machines</b>	6%	50%	50%	100%
M2	Operate and maintain hones and lapping machines		✓	✓	
<b>Line N</b>	<b>Use Grinders and Abrasives</b>	8%	50%	50%	100%
N1	Describe types of grinders		✓		
N2	Select abrasives		✓	✓	
N3	Operate and maintain grinders		✓	✓	
<b>Line O</b>	<b>Use Boring Machines</b>	5%	100%	0%	100%
O1	Describe boring mills		✓		
O2	Operate and maintain vertical boring mills		✓		
<b>Total Percentage for Machinist Level 3</b>		<b>100%</b>			



## Training Topics and Suggested Time Allocation

### MACHINIST – LEVEL 4

		% of Time Allocated to:			
		% of Time	Theory	Practical	Total
<b>Line D</b>	<b>Use Measuring Tools</b>	<b>7%</b>	<b>50%</b>	<b>50%</b>	<b>100%</b>
D5	Describe optical measuring equipment		✓	✓	
<b>Line E</b>	<b>Interpret Drawings and Reference Materials</b>	<b>9%</b>	<b>100%</b>	<b>0%</b>	<b>100%</b>
E3	Use Machinery's Handbook and other reference materials		✓		
<b>Line F</b>	<b>Select Materials</b>	<b>9%</b>	<b>100%</b>	<b>0%</b>	<b>100%</b>
F1	Describe principles of metallurgy		✓		
F2	Describe characteristics of ferrous metals		✓		
F3	Describe characteristics of non-ferrous metals		✓		
F4	Describe characteristics of non-metals		✓		
F6	Describe and perform heat treating		✓		
F7	Describe materials testing		✓		
<b>Line G</b>	<b>Plan Sequence of Operation</b>	<b>5%</b>	<b>50%</b>	<b>50%</b>	<b>100%</b>
G1	Determine project requirements		✓	✓	
G3	Perform roughing and finishing			✓	
<b>Line M</b>	<b>Use Support Machines</b>	<b>11%</b>	<b>70%</b>	<b>30%</b>	<b>100%</b>
M3	Operate and maintain gear cutting and electrical discharge machines		✓	✓	
<b>Line O</b>	<b>Use Boring Machines</b>	<b>4%</b>	<b>100%</b>	<b>0%</b>	<b>100%</b>
O1	Describe boring mills		✓		
O3	Operate and maintain horizontal boring mills		✓		
<b>Line P</b>	<b>Use C.N.C. Machines</b>	<b>55%</b>	<b>70%</b>	<b>30%</b>	<b>100%</b>
P1	Describe C.N.C. machines		✓		
P2	Describe co-ordinate systems and programming codes		✓		
P3	Operate and maintain C.N.C. machines		✓	✓	
<b>Total Percentage for Machinist Level 4</b>		<b>100%</b>			



# **Section 3**

# **PROGRAM CONTENT**

# **Machinist**



# Level 1

# Machinist



**Line (GAC):           A    USE SAFE WORK PRACTICES**  
**Competency:         A1   Describe Occupational Health and Safety Regulations**

**Objectives**

To be competent in this area, the individual must be able to:

- Describe the application of the parts of the Workers’ Compensation Act outlined in this Occupation Health and Safety Regulations.
- Describe the application of the Occupational Health and Safety Regulations and know how to find requirements applicable to the machinist workplace.

**LEARNING TASKS**

**CONTENT**

- |   |  |
|---|--|
| <ol style="list-style-type: none"> <li>1. Define terms used in Federal-Provincial Occupational Health and Safety Regulations</li> <br/> <li>2. Describe the Occupational Health and Safety Regulations</li> </ol> | <ul style="list-style-type: none"> <li>• Workers Compensation Act</li> <li>• Industrial Health and Safety Regulations</li> <li>• Federal Regulations</li> <li>• Other Federal jurisdictions</li> <li>• British Columbia Mines Act</li> <li>• WHMIS (Workplace Hazardous Materials Information System) Definitions, Section 1 of the Act</li> <br/> <li>• Housekeeping <ul style="list-style-type: none"> <li>○ Confined Space</li> <li>○ Material Storage</li> <li>○ Ladders/Scaffolding</li> <li>○ Fall Arrest</li> <li>○ WHMIS</li> <li>○ Lockout/Tagout procedures</li> <li>○ Ventilation requirements</li> <li>○ Chemical and Biological substances</li> <li>○ Noise, vibration, radiation and temperature</li> <li>○ Personal protective equipment requirements</li> <li>○ Accident reporting requirements</li> </ul> </li> </ul> |
|---|--|





**Line (GAC):           A    USE SAFE WORK PRACTICES**  
**Competency:         A2   Describe Workplace Hazardous Materials Information System (WHMIS) Regulations and Hazardous Materials Safety (HAZMAT)**

**Objectives**

To be competent in this area, the individual must be able to:

- Describe the purpose of HAZMAT (Hazardous Materials Safety) regulations and the WHMIS regulations.
- Explain the contents and employee responsibility regarding HAZMAT regulations and the WHMIS regulations.
- Interpret material information sheets (MSDS (Material Safety Data Sheets) and HAZMAT).
- Apply knowledge of WHMIS and HAZMAT regulations to maintain a safe working environment.

**LEARNING TASKS**

**CONTENT**

- |   |  |
|---|--|
| <ol style="list-style-type: none"> <li>1. Describe HAZMAT regulations for the transportation of hazardous materials</li> <li>2. State the legislation that requires suppliers of hazardous materials to provide MSDSs and label products as a condition of sale and importation</li> <li>3. State the work purpose of the Workplace Hazardous Materials Information System (WHMIS)</li> <li>4. Describe the key elements of WHMIS</li> <li>5. Describe the responsibilities of suppliers under WHMIS</li> </ol> | <ul style="list-style-type: none"> <li>• Signage</li> <li>• Reporting incidents</li> <li>• Safe handling and cleanup procedures</li> <li>• Transporting</li> <li>• Hazardous Product Act</li> <li>• Controlled Products Regulations</li> <li>• Ingredient Disclosure List</li> <li>• Hazardous Materials Information Review Act</li> <li>• Hazardous Material Information Review Regulations</li> <li>• Protection of Canadian workers from the adverse effects of hazardous materials through the provision of relevant information while minimizing the economic impact on industry and the disruption of trade</li> <li>• Recognition of rights               <ul style="list-style-type: none"> <li>○ Workers</li> <li>○ Employers</li> <li>○ Suppliers</li> <li>○ Regulations</li> </ul> </li> <li>• Material Safety Data Sheets (MSDSs)</li> <li>• Labeling of containers of hazardous materials</li> <li>• Worker educational programs</li> <li>• Provide               <ul style="list-style-type: none"> <li>○ MSDSs</li> <li>○ Labels</li> </ul> </li> </ul> |
|---|--|



**LEARNING TASKS**

**CONTENT**

- |   |   |
|---|---|
| <p>6. Describe the responsibilities of employers under WHMIS</p>                        | <ul style="list-style-type: none"> <li>• Provide               <ul style="list-style-type: none"> <li>○ MSDSs</li> <li>○ Labels</li> <li>○ Work education programs in the workplace</li> </ul> </li> </ul>  |
| <p>7. Describe information to be disclosed on a MSDS</p>                                | <ul style="list-style-type: none"> <li>• Hazardous ingredients</li> <li>• Preparation information</li> <li>• Product information</li> <li>• Physical data</li> <li>• Fire or explosion</li> <li>• Reactivity data</li> <li>• Toxicological properties</li> <li>• Preventive measures</li> <li>• First Aid measures</li> </ul>   |
| <p>8. Identify symbols found on WHMIS labels and their meaning</p>                      | <ul style="list-style-type: none"> <li>• Compressed gases</li> <li>• Flammable and combustible materials</li> <li>• Oxidizing materials</li> <li>• Poisonous and infectious materials               <ul style="list-style-type: none"> <li>○ Materials causing immediate and serious side effects</li> <li>○ Materials causing other toxic effects</li> <li>○ Biohazardous infectious materials</li> </ul> </li> <li>• Corrosive materials</li> <li>• Dangerously reactive materials</li> </ul> |
| <p>9. Apply WHMIS regulations as they apply to hazardous materials used in the shop</p> | <ul style="list-style-type: none"> <li>• Use, storage and disposal of               <ul style="list-style-type: none"> <li>○ Solvents</li> <li>○ Cutting fluids</li> <li>○ Materials                   <ul style="list-style-type: none"> <li>– Metals</li> <li>– Plastic</li> </ul> </li> <li>○ Caustic cleaners</li> <li>○ Cleaning solutions</li> <li>○ Alcohol used for cleaning</li> <li>○ Oxy-acetylene</li> <li>○ Asbestos</li> <li>○ Tracer dyes</li> </ul> </li> </ul>                 |
| <p>10. Maintain safe working area</p>   | <ul style="list-style-type: none"> <li>• Demonstrate an understanding of HAZMAT and WHMIS regulations</li> </ul>  |





### LEARNING TASKS

### CONTENT

- |  |  |
|--|--|
| <p>3. Locate shop emergency equipment and means of egress)</p>   | <ul style="list-style-type: none"> <li>• Emergency shutoffs</li> <li>• Fire control systems</li> <li>• Eye wash facilities</li> <li>• Emergency exits</li> <li>• First aid facilities</li> <li>• Emergency contact phone numbers</li> <li>• Evacuation procedures</li> <li>• Outside meeting place</li> <li>• Disaster meeting place</li> </ul>  |
| <p>4. Describe the conditions necessary to support a fire</p>  | <ul style="list-style-type: none"> <li>• Air</li> <li>• Fuel</li> <li>• Heat</li> </ul>  |
| <p>5. Describe the classes of fires according to the materials being burned</p>  | <ul style="list-style-type: none"> <li>• Class A</li> <li>• Class B</li> <li>• Class C</li> <li>• Class D</li> <li>• Symbols and colours</li> </ul>  |
| <p>6. Apply preventative fire safety precautions when working near, handling or storing flammable liquids or gases, combustible materials and electrical apparatus</p> | <ul style="list-style-type: none"> <li>• Solvents</li> <li>• Heat treatment salts               <ul style="list-style-type: none"> <li>○ Potassium Cyanide</li> </ul> </li> <li>• Oxygen</li> <li>• Acetylene</li> <li>• LPG and CNG</li> <li>• Ventilation               <ul style="list-style-type: none"> <li>○ Purging</li> </ul> </li> <li>• Lubricants</li> <li>• Oily rags</li> <li>• Combustible metals</li> <li>• Aerosols</li> </ul> |
| <p>7. Describe the considerations and steps to be taken prior to fighting a fire</p>   | <ul style="list-style-type: none"> <li>• Warning others and fire departments</li> <li>• Evacuation of others</li> <li>• Containable fire</li> <li>• Personal escape route</li> <li>• Training</li> </ul>   |
| <p>8. Describe the procedure for using a fire extinguisher</p>   | <ul style="list-style-type: none"> <li>• P.A.S.S.               <ul style="list-style-type: none"> <li>○ Pull</li> <li>○ Aim</li> <li>○ Squeeze</li> <li>○ Sweep</li> </ul> </li> </ul>  |



**Achievement Criteria**

Performance	The learner will be evaluated on the ability to: <ul style="list-style-type: none"><li>• Perform lab practical tasks while taking personal safety precautions and follow personal safety procedures</li><li>• Lock out equipment prior to servicing</li><li>• Locate shop emergency equipment and means of egress</li></ul>
Conditions	As part of practical lab tasks, given the required tools and materials.
Criteria	Tasks must be performed within specifications, safety standards and time frames acceptable to industry.



**Line (GAC):        A    USE SAFE WORK PRACTICES**  
**Competency        A4    Use Lifting Equipment**

**Objectives**

To be competent in this area, the individual must be able to:

- Apply the Occupational Health and Safety Regulation to lifting and blocking applications.
- Select, use and maintain lifting, securing and blocking equipment.
- Lift, move and manipulate loads.

**LEARNING TASKS**

**CONTENT**

- |   |  |
|---|--|
| <ol style="list-style-type: none"> <li>1. Apply the Occupational Health and Safety Regulation</li> <li>2. Determine load masses</li> <li>3. Determine load masses</li> <li>4. Select, use and maintain securing equipment</li> <li>5. Select, use and maintain wire ropes, chains and lifting straps</li> <li>6. Use visual and sound signals</li> <li>7. Select, use and maintain hoisting equipment</li> <li>8. Lift, hoist and move loads</li> <li>9. Manoeuvre large objects</li> </ol> | <ul style="list-style-type: none"> <li>• Parts 14 and 15</li> <li>• Manufacturer’s specification</li> <li>• Estimation</li> <li>• Types</li> <li>• Capacities</li> <li>• Types <ul style="list-style-type: none"> <li>○ Clamps</li> <li>○ Material racks</li> <li>○ Blocking</li> </ul> </li> <li>• Load capacities</li> <li>• Types</li> <li>• Capacities</li> <li>• Rigging attachments</li> <li>• Lifting attachments</li> <li>• Occupation Health and Safety Regulation (Part 15)</li> <li>• Types</li> <li>• Capacities</li> <li>• Operation</li> <li>• Determine safe working load</li> <li>• Determine correct slinging procedure</li> <li>• Flipping</li> <li>• Rotating</li> <li>• Centre of gravity</li> <li>• Sling or chain placement</li> </ul> |
|---|--|



**Achievement Criteria**

- Performance The learner will be evaluated on the ability to:
- Select, use and maintain lifting, securing and blocking equipment
  - Lift, move and manipulate loads
- Conditions As part of practical lab tasks, given the required tools and materials.
- Criteria Tasks must be performed within specifications, safety standards and time frames acceptable to industry.



**Line (GAC):        B    USE HAND TOOLS**  
**Competency:        B1    Use and Maintain Hand Tools**

**Objectives**

To be competent in this area, the individual must be able to:

- Select, use and maintain hand tools.
- Select, use and maintain appropriate guarding and personal protective equipment.

**LEARNING TASKS**

**CONTENT**

- |   |   |
|---|---|
| <p>1.    Use protective equipment associated with the use of tools and shop equipment</p> | <ul style="list-style-type: none"> <li>• Personal protection               <ul style="list-style-type: none"> <li>○ Head</li> <li>○ Hands</li> <li>○ Lungs</li> <li>○ Eyes</li> <li>○ Ears</li> <li>○ Feet</li> <li>○ Clothing</li> </ul> </li> <li>• Screening</li> <li>• Guarding</li> <li>• Ventilation</li> <li>• Clean up</li> <li>• Lock out</li> </ul> |
| <p>2.    Select, use and maintain hand tools</p>  | <ul style="list-style-type: none"> <li>• Wrenches</li> <li>• Screwdrivers</li> <li>• Cutting               <ul style="list-style-type: none"> <li>○ Saws</li> <li>○ Abrasives</li> <li>○ Files</li> <li>○ Taps and dies</li> </ul> </li> <li>• Hammers</li> <li>• Chisels/punches</li> <li>• Clamping tools</li> <li>• Pullers</li> <li>• Vises</li> </ul>    |

**Achievement Criteria**

- Performance**    The learner will be evaluated on the ability to:
- Select, use and maintain hand tools as described
- Conditions**     As part of practical lab tasks, given the required tools and materials.
- Criteria**         Tasks must be performed within specifications, safety standards and time frames acceptable to industry.





**Line (GAC): B USE HAND TOOLS**

**Competency: B2 Use Layout Tools**

**Objectives**

To be competent in this area, the individual must be able to:

- Select, use and maintain layout tools.
- Perform layout procedures.

**LEARNING TASKS**

**CONTENT**

- |                               |  |
|-------------------------------|--|
| 1. Select layout tools        | <ul style="list-style-type: none"> <li>• Layout dye</li> <li>• Scribes</li> <li>• Dividers</li> <li>• Centre punch</li> <li>• Height gauges</li> <li>• Rulers</li> <li>• Combination set</li> <li>• Surface gauge</li> <li>• V-blocks</li> <li>• Angle plates</li> </ul>     |
| 2. Describe layout procedures | <ul style="list-style-type: none"> <li>• Material selection               <ul style="list-style-type: none"> <li>○ Adequate stock size</li> </ul> </li> <li>• Establish procedures steps</li> <li>• Datum points</li> <li>• Datum faces</li> <li>• Tool selection</li> </ul> |
| 3. Perform layout procedures  | <ul style="list-style-type: none"> <li>• As in Learning Task 1 and 2</li> </ul>  |

**Achievement Criteria**

Performance The learner will be evaluated on the ability to:

- Select, use and maintain layout tools as described
- Perform layout procedures

Conditions As part of practical lab tasks, given the required tools and materials.

Criteria Tasks must be performed within specifications, safety standards and time frames acceptable to industry.



**Line (GAC):**        **B    USE HAND TOOLS**  
**Competency:**      **B3   Use and Maintain Handheld Power Tools**

**Objectives**

To be competent in this area, the individual must be able to:

- Describe handheld power tool safety.
- Select, use and maintain handheld power tools.
- Maintain handheld power tool accessories.

**LEARNING TASKS**

**CONTENT**

- |  |   |
|--|---|
| <p>1.    Describe handheld power tool safety</p>                 | <ul style="list-style-type: none"> <li>• Personal protective equipment</li> <li>• Guards</li> <li>• Electrical cords</li> <li>• Operating procedures <ul style="list-style-type: none"> <li>○ Securing work</li> </ul> </li> <li>• Compressed air</li> <li>• Tool maintenance</li> </ul>    |
| <p>2.    Select handheld power tools</p>                         | <ul style="list-style-type: none"> <li>• Electric <ul style="list-style-type: none"> <li>○ Cutting</li> <li>○ Grinding</li> <li>○ Drilling</li> </ul> </li> <li>• Pneumatic <ul style="list-style-type: none"> <li>○ Cutting</li> <li>○ Grinding</li> <li>○ Drilling</li> </ul> </li> </ul> |
| <p>3.    Select and maintain handheld power tool accessories</p> | <ul style="list-style-type: none"> <li>• Drill Sharpening</li> <li>• Grinding wheel speeds</li> <li>• Burr speeds</li> <li>• Cut-off wheels</li> <li>• Abrasive discs</li> <li>• Saw blades <ul style="list-style-type: none"> <li>○ Band</li> <li>○ Circular</li> </ul> </li> </ul>        |
| <p>4.    Use handheld power tools</p>                            | <ul style="list-style-type: none"> <li>• As in learning tasks 2 and 3</li> </ul>  |



**Achievement Criteria**

- Performance The learner will be evaluated on the ability to:
- Select, use and maintain handheld power tools as described
  - Maintain handheld power tool accessories
- Conditions As part of practical lab tasks, given the required tools and materials.
- Criteria Tasks must be performed within specifications, safety standards and time frames acceptable to industry.



**Line (GAC):**        **B    USE HAND TOOLS**  
**Competency:**      **B4   Mark Workpieces for Identification**

**Objectives**

To be competent in this area, the individual must be able to:

- Identify and describe marking procedures.
- Mark workpieces without causing them functional damage.

**LEARNING TASKS**

**CONTENT**

1.    Identify and describe workpiece marking procedures	<ul style="list-style-type: none"> <li>• Etching</li> <li>• Engraving</li> <li>• Colour coding</li> <li>• Stamping</li> </ul>
2.    Mark workpieces without causing damage	<ul style="list-style-type: none"> <li>• Engraving</li> <li>• Colour coding</li> <li>• Ink stamping</li> <li>• Acid etching</li> </ul>

**Achievement Criteria**

Performance	The learner will be evaluated on the ability to: <ul style="list-style-type: none"> <li>• Mark workpieces without causing damage</li> </ul>
Conditions	As part of practical lab tasks, given the required tools and materials.
Criteria	Tasks must be performed within specifications, safety standards and time frames acceptable to industry.



**Line (GAC):**        **C    USE APPLIED MATHEMATICS**  
**Competency:**      **C1   Solve Problems Involving Formulas**

**Objectives**

To be competent in this area, the individual must be able to:

- Perform calculations using formulas.
- Use a scientific calculator.

**LEARNING TASKS**

**CONTENT**

- |  |   |
|--|---|
| <p>1.    Use formulas</p>                | <ul style="list-style-type: none"> <li>• Trigonometry</li> <li>• Threading</li> <li>• Feeds and Speeds</li> <li>• Circumference</li> <li>• Area</li> <li>• Volume</li> <li>• Mass</li> <li>• Gearing</li> <li>• Tapers</li> </ul>                     |
| <p>2.    Use a scientific calculator</p> | <ul style="list-style-type: none"> <li>• Brackets</li> <li>• Memory</li> <li>• Fractions</li> <li>• Percentages</li> <li>• Conversions</li> <li>• Trigonometry</li> <li>• Inversion</li> <li>• Power</li> <li>• Roots</li> <li>• Constants</li> </ul> |



**Line (GAC):** C USE APPLIED MATHEMATICS  
**Competency:** C2 Solve Problems Involving Ratios

**Objectives**

To be competent in this area, the individual must be able to:

- Calculate ratios.

**LEARNING TASKS**

1. Apply ratios

**CONTENT**

- Direct
- Inverse



**Line (GAC):** C **USE APPLIED MATHEMATICS**  
**Competency:** C3 **Solve Problems Involving Metric / Imperial Conversions**

**Objectives**

To be competent in this area, the individual must be able to:

- Define metric and imperial units of measure.
- Define metric prefixes.
- Perform metric to imperial conversions.
- Perform imperial to metric conversions.

**LEARNING TASKS**

**CONTENT**

- |                           |   |
|---------------------------|---|
| 1. Define metric units    | <ul style="list-style-type: none"> <li>• Length</li> <li>• Mass</li> <li>• Volume</li> <li>• Temperature</li> <li>• Force</li> <li>• Torque</li> <li>• Power</li> </ul> |
| 2. Define metric prefixes | <ul style="list-style-type: none"> <li>• Place value</li> <li>• Scientific notation</li> </ul>  |
| 3. Define imperial units  | <ul style="list-style-type: none"> <li>• Length</li> <li>• Mass</li> <li>• Volume</li> <li>• Temperature</li> <li>• Force</li> <li>• Torque</li> <li>• Power</li> </ul> |
| 4. Calculate conversions  | <ul style="list-style-type: none"> <li>• Length</li> <li>• Mass</li> <li>• Volume</li> <li>• Temperature</li> <li>• Force</li> <li>• Torque</li> <li>• Power</li> </ul> |



**Line (GAC):** C USE APPLIED MATHEMATICS  
**Competency:** C4 Solve Problems Involving Geometry

### Objectives

To be competent in this area, the individual must be able to:

- Identify types of geometric construction.
- Perform geometric construction and layout procedures.

### LEARNING TASKS

1. Solve geometric problems

### CONTENT

- Bisect
- Right angle
- Perpendicular
- Parallel
- Circles
- Arcs
- Tangent
- Layout procedures





**Line (GAC):**        **C    USE APPLIED MATHEMATICS**  
**Competency:**      **C5   Solve Problems Involving Algebra**

**Objectives**

To be competent in this area, the individual must be able to:

- Solve problems using algebra.
- Solve problems by transposing formulas.

**LEARNING TASKS**

**CONTENT**

1.    Use algebra

- Proportions
- Algebraic calculations
- Transpose formulas



**Line (GAC):** C USE APPLIED MATHEMATICS  
**Competency:** C6 Solve Problems Involving Mass, Area and Volume

### Objectives

To be competent in this area, the individual must be able to:

- Calculate mass, area and volume.

### LEARNING TASKS

1. Calculate mass
2. Calculate area
3. Calculate volume

### CONTENT

- Weight
  - Steel
  - Aluminum
  - Fluids
- Specific Gravity
- Two dimensional geometric shapes
- Three dimensional geometric shapes



**Line (GAC):**        **C**    **USE APPLIED MATHEMATICS**  
**Competency:**      **C7**   **Solve Problems Involving Trigonometry**

**Objectives**

To be competent in this area, the individual must be able to:

- Describe trigonometry applications.
- Apply trigonometry applications.

**LEARNING TASKS**

**CONTENT**

- |  |   |
|--|---|
| <ol style="list-style-type: none"> <li>1. Describe trigonometry</li> <br/><br/><br/><br/> <li>2. Use applied trigonometry</li> </ol> | <ul style="list-style-type: none"> <li>• Pythagoras theorem</li> <li>• Triangles</li> <li>• Sine</li> <li>• Cosine</li> <li>• Tangent</li> <br/> <li>• Bolt circles</li> <li>• Layout procedures <ul style="list-style-type: none"> <li>○ Chords</li> </ul> </li> </ul> |
|--|---|



**Line (GAC):**        **D    USE MEASURING TOOLS**  
**Competency:**     **D1   Use Linear and Vernier Scales**

**Objectives**

To be competent in this area, the individual must be able to:

- Describe linear and vernier scales.
- Use linear and vernier scales.

**LEARNING TASKS**

**CONTENT**

- |   |   |
|---|---|
| <p>1.    Describe linear and vernier scales</p> | <ul style="list-style-type: none"> <li>• Imperial rule</li> <li>• Metric rule</li> <li>• Decimal rule</li> <li>• Vernier (Digital and Dial) <ul style="list-style-type: none"> <li>○ Caliper</li> <li>○ Height Gauge</li> <li>○ Protractor</li> </ul> </li> <li>• Read</li> <li>• Care and maintenance</li> </ul> |
| <p>2.    Use linear and vernier scales</p>      | <ul style="list-style-type: none"> <li>• Imperial rule</li> <li>• Metric rule</li> <li>• Decimal rule</li> <li>• Vernier (Digital and Dial) <ul style="list-style-type: none"> <li>○ Caliper</li> <li>○ Height Gauge</li> <li>○ Protractor</li> </ul> </li> <li>• Read</li> <li>• Care and maintenance</li> </ul> |

**Achievement Criteria**

- Performance**    The learner will be evaluated on the ability to:
- Use linear and vernier scales
- Conditions**     As part of practical lab tasks, given the required tools and materials.
- Criteria**         Tasks must be performed within specifications, safety standards and time frames acceptable to industry.



**Line (GAC):**        **D    USE MEASURING TOOLS**

**Competency:**     **D2   Use Micrometers**

**Objectives**

To be competent in this area, the individual must be able to:

- Describe micrometer construction, operation and maintenance.
- Use and maintain a micrometer.

**LEARNING TASKS**

**CONTENT**

1.     Describe micrometers

- Types
  - Outside
  - Inside
  - Depth
  - Thread
- Read
- Parts
- Calibrate
- Care and Maintenance

2.     Use micrometers

- Types
  - Outside
  - Inside
  - Depth
  - Thread
- Read
- Parts
- Calibrate
- Care and Maintenance

**Achievement Criteria**

**Performance**    The learner will be evaluated on the ability to:

- Read, calibrate, care for and maintain the listed types of micrometers

**Conditions**     As part of practical lab tasks, given the required tools and materials.

**Criteria**         Tasks must be performed within specifications, safety standards and time frames acceptable to industry.



**Line (GAC):**        **D    USE MEASURING TOOLS**  
**Competency:**      **D3    Use Callipers and Gauges**

**Objectives**

To be competent in this area, the individual must be able to:

- Describe callipers.
- Describe gauges.
- Use callipers.
- Use gauges.

**LEARNING TASKS**

**CONTENT**

- |                          |   |
|--------------------------|---|
| 1.    Describe callipers | <ul style="list-style-type: none"> <li>• Types <ul style="list-style-type: none"> <li>○ Inside</li> <li>○ Outside</li> <li>○ Hermaphrodite</li> <li>○ Transfer</li> </ul> </li> </ul> |
| 2.    Describe gauges    | <ul style="list-style-type: none"> <li>• Types <ul style="list-style-type: none"> <li>○ Radius</li> <li>○ Telescopic</li> </ul> </li> </ul>   |
| 3.    Use callipers      | <ul style="list-style-type: none"> <li>• Types <ul style="list-style-type: none"> <li>○ Inside</li> <li>○ Outside</li> <li>○ Hermaphrodite</li> <li>○ Transfer</li> </ul> </li> </ul> |
| 4.    Use gauges         | <ul style="list-style-type: none"> <li>• Types <ul style="list-style-type: none"> <li>○ Radius</li> <li>○ Telescopic</li> </ul> </li> </ul>   |

**Achievement Criteria**

- Performance**    The learner will be evaluated on the ability to:
- Operate and maintain the listed types of callipers and gauges
- Conditions**      As part of practical lab tasks, given the required tools and materials.
- Criteria**            Tasks must be performed within specifications, safety standards and time frames acceptable to industry.



**Line (GAC):**        **D    USE MEASURING TOOLS**  
**Competency:**      **D4   Use Dial Indicators and Digital Readouts**

**Objectives**

To be competent in this area, the individual must be able to:

- Describe dial indicators and their use.
- Use dial indicators.

**LEARNING TASKS**

**CONTENT**

- |  |   |
|--|---|
| <ol style="list-style-type: none"> <li>1. Describe dial indicators</li> <br/><br/><br/><br/><br/><br/><br/><br/><br/><br/> <li>2. Use dial indicators</li> </ol> | <ul style="list-style-type: none"> <li>• Types and features             <ul style="list-style-type: none"> <li>○ Clock type</li> <li>○ Finger type</li> </ul> </li> <li>• Graduations</li> <li>• Accessories</li> <li>• Uses             <ul style="list-style-type: none"> <li>○ Comparing measurements</li> <li>○ Setting up</li> <li>○ Measuring</li> </ul> </li> <li>• Care and maintenance</li> <br/><br/><br/><br/><br/><br/><br/> <li>• True workpiece             <ul style="list-style-type: none"> <li>○ Lathe</li> </ul> </li> <li>• Workpiece inspection</li> <li>• Care and maintenance</li> </ul> |
|--|---|

**Achievement Criteria**

**Performance**    The learner will be evaluated on the ability to:

- Operate, care for and maintain clock and finger type dial indicators

**Conditions**      As part of practical lab tasks, given the required tools and materials.

**Criteria**          Tasks must be performed within specifications, safety standards and time frames acceptable to industry.



**Line (GAC):** E **INTERPRET DRAWINGS AND REFERENCE MATERIALS**  
**Competency:** E1 **Interpret Information Found on Drawings**

### Objectives

To be competent in this area, the individual must be able to:

- Identify lines and symbols found on drawings.
- Identify views and projections used on drawings.
- Interpret information found in title blocks.

### LEARNING TASKS

### CONTENT

- |  |  |
|--|--|
| <p>1. Identify lines found in drawings</p>   | <ul style="list-style-type: none"> <li>• Line types               <ul style="list-style-type: none"> <li>○ Solid line</li> <li>○ Centre line</li> <li>○ Hidden line</li> <li>○ Extension lines</li> <li>○ Dimension lines</li> <li>○ Section lines</li> <li>○ Construction lines</li> </ul> </li> <li>• Purpose</li> <li>• Application</li> </ul>  |
| <p>2. Identify symbols found in drawings</p> | <ul style="list-style-type: none"> <li>• Symbol types               <ul style="list-style-type: none"> <li>○ Surface finish</li> <li>○ Welding</li> <li>○ Datum</li> <li>○ Geometric tolerance</li> <li>○ Diameter</li> <li>○ ISO</li> </ul> </li> <li>• Purpose</li> <li>• Application</li> </ul>   |
| <p>3. Identify views and projections</p>     | <ul style="list-style-type: none"> <li>• Types</li> <li>• Orthographic projections               <ul style="list-style-type: none"> <li>○ 1<sup>st</sup> and 3<sup>rd</sup> angle</li> <li>○ Isometric views</li> <li>○ Oblique views</li> <li>○ Shop Sketches (working drawings)</li> </ul> </li> <li>• Purpose</li> <li>• Application</li> </ul> |





4. Interpret title block information
- Scale
  - Revisions
  - Date
  - Material
    - Type
    - Size
  - Tolerances
  - Projection type
  - Measurement system

### **Achievement Criteria**

Performance The learner will be evaluated on the ability to:

- Identify lines, symbols, views and projections
- Interpret title block information

Conditions As part of practical lab tasks, given the required tools and materials.

Criteria Tasks must be performed within specifications, safety standards and time frames acceptable to industry.



**Line (GAC):**        **E**    **INTERPRET DRAWINGS AND REFERENCE MATERIALS**  
**Competency:**      **E2**    **Sketch Machined Parts**

**Objectives**

To be competent in this area, the individual must be able to:

- Sketch and dimension an orthographic drawing from an existing part.
- Sketch and dimension and orthographic drawing from an isometric or oblique view.

**LEARNING TASKS**

**CONTENT**

1. Sketch and dimension an orthographic drawing from an existing part	<ul style="list-style-type: none"> <li>• Information required for part manufacture</li> <li>• Necessary views</li> <li>• Dimensioning</li> <li>• Material</li> <li>• Tolerances</li> </ul>
2. Sketch and dimension and orthographic drawing from an isometric or oblique view	<ul style="list-style-type: none"> <li>• Information required for part manufacture</li> <li>• Necessary views</li> <li>• Dimensioning</li> <li>• Material</li> <li>• Tolerances</li> </ul>

**Achievement Criteria**

Performance	The learner will be evaluated on the ability to: <ul style="list-style-type: none"> <li>• Sketch and dimension an orthographic drawing from an existing part</li> <li>• Sketch and dimension an orthographic drawing from an isometric or oblique view</li> </ul>
Conditions	As part of practical lab tasks, given the required tools and materials.
Criteria	Tasks must be performed within specifications, safety standards and time frames acceptable to industry.



**Line (GAC):** E **INTERPRET DRAWINGS AND REFERENCE MATERIALS**  
**Competency:** E3 **Use Machinery's Handbook and Other Reference Materials**

**Objectives**

To be competent in this area, the individual must be able to:

- Identify information found in the Machinery's Handbook.
- Locate information in the Machinery's Handbook.
- Use other reference materials and resources to locate information.

**LEARNING TASKS**

**CONTENT**

- |   |   |
|---|---|
| 1. Identify information found in the Machinery's Handbook | <ul style="list-style-type: none"> <li>• Types               <ul style="list-style-type: none"> <li>○ Charts</li> <li>○ Tables</li> <li>○ Threads</li> </ul> </li> </ul>  |
| 2. Locate information in the Machinery's Handbook         | <ul style="list-style-type: none"> <li>• Familiarization with book layout</li> <li>• Index</li> <li>• Section tabs</li> <li>• Tables</li> <li>• Thread data</li> <li>• Fits and tolerances</li> <li>• Formulas</li> <li>• Speeds and feeds</li> </ul>   |
| 3. Use other reference materials                          | <ul style="list-style-type: none"> <li>• Tooling catalogues</li> <li>• Trade specific magazines</li> <li>• Trade bulletins</li> <li>• Internet</li> <li>• Machine manuals</li> <li>• Job plan               <ul style="list-style-type: none"> <li>○ machine limitations</li> </ul> </li> <li>• Quality Control Documentation               <ul style="list-style-type: none"> <li>○ inspection sheets</li> <li>○ blueprints</li> </ul> </li> </ul> |



**Achievement Criteria**

Performance	The learner will be evaluated on the ability to: <ul style="list-style-type: none"><li>• Locate and use information in the Machinery's Handbook to complete tasks and projects</li><li>• Locate and use information in other reference materials to complete tasks and projects</li></ul>
Conditions	As part of practical lab tasks, given the required tools and materials.
Criteria	Tasks must be performed within specifications, safety standards and time frames acceptable to industry.



**Line (GAC):** E **INTERPRET DRAWINGS AND REFERENCE MATERIALS**  
**Competency:** E4 **Describe Fits and Tolerances**

**Objectives**

To be competent in this area, the individual must be able to:

- Describe fits and tolerances.
- Describe surface finishes.

**LEARNING TASKS**

**CONTENT**

- |  |   |
|--|---|
| <p>1. Describe fits and tolerances</p> | <ul style="list-style-type: none"> <li>• Standards               <ul style="list-style-type: none"> <li>○ ANSI</li> <li>○ ISO</li> </ul> </li> <li>• Types               <ul style="list-style-type: none"> <li>○ Fits</li> <li>○ Tolerances</li> </ul> </li> <li>• Applications</li> </ul> |
| <p>2. Apply surface finishes</p>       | <ul style="list-style-type: none"> <li>• Types</li> <li>• Methods of Measurement               <ul style="list-style-type: none"> <li>○ Comparative</li> <li>○ Stylus</li> </ul> </li> <li>• Applications</li> </ul>  |

**Achievement Criteria**

- Performance** The learner will be evaluated on the ability to:
- Apply surface finishes
- Conditions** As part of practical lab tasks, given the required tools and materials.
- Criteria** Tasks must be performed within specifications, safety standards and time frames acceptable to industry.



**Line (GAC):           G    PLAN SEQUENCE OF OPERATION**

**Competency:         G1   Determine Project Requirements**

**Objectives**

To be competent in this area, the individual must be able to:

- Determine project requirements from a drawing or sample.
- Plan manufacturing sequences.

**LEARNING TASKS**

**CONTENT**

1. Plan the sequence of bench work and lathe operations

- Material requirements
  - Types
  - Machining allowances
- Machine tool
  - Rough stock preparation
  - Machining
- Select Tooling
- Select work holding devices
- Optional processes
  - Welding
  - Heat treatment
  - Plating
- Inspection
- Lathes
  - Turning
  - Boring
  - Imperial threading
  - Taper turning

**Achievement Criteria**

**Performance**   The learner will be evaluated on the ability to:

- Determine project requirements from a drawing or sample
- Plan manufacturing sequences

**Conditions**    As part of practical lab tasks, given the required tools and materials.

**Criteria**       Tasks must be performed within specifications, safety standards and time frames acceptable to industry.



**Line (GAC):**        **G**    **PLAN SEQUENCE OF OPERATION**  
**Competency:**     **G2**   **Describe Work Holding Devices**

**Objectives**

To be competent in this area, the individual must be able to:

- Describe various work holding devices and their applications.
- Select and use work holding devices.

**LEARNING TASKS**

**CONTENT**

- |   |  |
|---|--|
| <p>1. Describe and use work holding devices</p> | <ul style="list-style-type: none"> <li>• Types <ul style="list-style-type: none"> <li>○ Chucks</li> <li>○ Vices</li> <li>○ Clamps</li> <li>○ Face Plates</li> <li>○ Angle plates</li> <li>○ Arbours</li> <li>○ Mandrels</li> <li>○ Jigs</li> <li>○ Fixtures</li> </ul> </li> </ul> |
|---|--|

**Achievement Criteria**

**Performance**    The learner will be evaluated on the ability to:

- Select and use work holding devices

**Conditions**     As part of practical lab tasks, given the required tools and materials.

**Criteria**         Tasks must be performed within specifications, safety standards and time frames acceptable to industry.



**Line (GAC):**        **G    PLAN SEQUENCE OF OPERATION**  
**Competency:**     **G3   Perform Roughing and Finishing**

**Objectives**

To be competent in this area, the individual must be able to:

- Perform roughing and finishing processes.

**LEARNING TASKS**

**CONTENT**

- |   |   |
|---|---|
| <p>1.    Perform roughing and finishing processes</p> | <ul style="list-style-type: none"> <li>• Roughing <ul style="list-style-type: none"> <li>○ Speeds and feeds</li> <li>○ Cutters</li> <li>○ Measuring</li> <li>○ Material allowance for finishing</li> </ul> </li> <li>• Finishing <ul style="list-style-type: none"> <li>○ Speeds and Feeds</li> <li>○ Cutters</li> <li>○ Measuring</li> </ul> </li> </ul> |
|---|---|

**Achievement Criteria**

**Performance**    The learner will be evaluated on the ability to:

- Perform roughing and finishing

**Conditions**     As part of practical lab tasks, given the required tools and materials.

**Criteria**         Tasks must be performed within specifications, safety standards and time frames acceptable to industry.





**Line (GAC):** H **DESCRIBE FABRICATION AND ASSEMBLY**  
**Competency:** H1 **Identify Fasteners**

**Objectives**

To be competent in this area, the individual must be able to:

- Identify fasteners for applications.

**LEARNING TASKS**

**CONTENT**

1. Identify fastener types

- Rivets
- Dowels/pins
- Threaded fasteners
  - Metric/Imperial
  - Grades/Markings
- Washers
- Locking devices
- Retainers



**Line (GAC):** H **DESCRIBE FABRICATION AND ASSEMBLY**  
**Competency:** H2 **Identify Lubricants and Sealants**

**Objectives**

To be competent in this area, the individual must be able to:

- Describe lubricants and their applications
- Describe sealants and their applications.

**LEARNING TASKS**

**CONTENT**

- |                        |   |
|------------------------|---|
| 1. Describe lubricants | <ul style="list-style-type: none"> <li>• Purpose</li> <li>• Types               <ul style="list-style-type: none"> <li>○ Oils</li> <li>○ Greases</li> <li>○ Dry Lubricants</li> </ul> </li> <li>• Applications</li> </ul> |
| 2. Describe sealants   | <ul style="list-style-type: none"> <li>• Purpose</li> <li>• Types</li> <li>• Applications</li> </ul>  |



**Line (GAC):** I **USE DRILLING MACHINES**  
**Competency:** I1 **Describe Drilling Machines**

### Objectives

To be competent in this area, the individual must be able to:

- Describe drilling machines and their applications.

### LEARNING TASKS

1. Describe drilling machines

### CONTENT

- Types
  - Sensitive
  - Floor
  - Radial arm
  - Magnetic base
  - Bench
  - Multi spindle
  - Gang drill
  - C.N.C.
  - High speed
- Size



**Line (GAC):** I **USE DRILLING MACHINES**  
**Competency:** I2 **Select and Maintain Cutting Tools**

**Objectives**

To be competent in this area, the individual must be able to:

- Select cutting tools.
- Maintain cutting tools.

**LEARNING TASKS**

**CONTENT**

1. Select cutting tools

- Types
  - Drills
  - Reamers
  - Countersinks
  - Counterbores
  - Spot facer
  - Taps
  - Boring bars
  - Hole saws

2. Maintain cutting tools

- Drill sharpening
  - Point-angle
  - Flat bottom
  - Split point
  - Web thinning
  - Brassing
- Boring tools

**Achievement Criteria**

**Performance** The learner will be evaluated on the ability to:

- Select and maintain cutting tools

**Conditions** As part of practical lab tasks, given the required tools and materials.

**Criteria** Tasks must be performed within specifications, safety standards and time frames acceptable to industry.



**Line (GAC):** I **USE DRILLING MACHINES**  
**Competency:** I3 **Operate and Maintain Drilling Machines**

**Objectives**

To be competent in this area, the individual must be able to:

- Set speeds and feeds.
- Perform clamping and fixturing.
- Install and remove tooling.
- Maintain drilling machine.
- Select cutting fluids for specific drilling applications.

**LEARNING TASKS**

**CONTENT**

- |                               |  |
|-------------------------------|--|
| 1. Set feeds and speeds       | <ul style="list-style-type: none"> <li>• Types of material</li> <li>• Size of cutter</li> <li>• Type of cutter</li> </ul>  |
| 2. Perform clamping           | <ul style="list-style-type: none"> <li>• Types               <ul style="list-style-type: none"> <li>○ V-blocks</li> <li>○ Vices</li> <li>○ Angle plates</li> <li>○ Jigs and fixtures                   <ul style="list-style-type: none"> <li>– Drill bushings</li> </ul> </li> </ul> </li> <li>• Clamps and hold-downs</li> </ul> |
| 3. Install and remove tooling | <ul style="list-style-type: none"> <li>• Types               <ul style="list-style-type: none"> <li>○ Chucks</li> <li>○ Sleeves</li> <li>○ Tapping heads</li> <li>○ Boring bar</li> </ul> </li> <li>• Accessories               <ul style="list-style-type: none"> <li>○ Drift</li> <li>○ Chuck key</li> </ul> </li> </ul>         |



- |  |  |
|--|--|
| 4. Operate drilling machines   | <ul style="list-style-type: none"> <li>• Layout material</li> <li>• Centre punch</li> <li>• Pulling a drill</li> <li>• Pilot drill</li> <li>• Drill</li> <li>• Chamfer</li> <li>• Ream</li> <li>• Counter bore</li> <li>• Tap</li> </ul> |
| 5. Maintain drilling machines  | <ul style="list-style-type: none"> <li>• Lubricate</li> <li>• Clean</li> <li>• Housekeeping</li> </ul>   |
| 6. Describe the purpose and usage of cutting fluids with drilling machines | <ul style="list-style-type: none"> <li>• Lubrication</li> <li>• Cooling</li> <li>• Chip removal</li> <li>• Tool life</li> </ul>  |
| 7. Select types of cutting fluids for specific applications                | <ul style="list-style-type: none"> <li>• Types               <ul style="list-style-type: none"> <li>○ Straight oils</li> <li>○ Soluble oils</li> <li>○ Semi-synthetic</li> <li>○ Synthetic</li> <li>○ Misting</li> </ul> </li> </ul>     |

**Achievement Criteria**

- Performance** The learner will be evaluated on the ability to:
- Determine project requirements from a drawing or sample
  - Plan manufacturing sequences
- Conditions** As part of practical lab tasks, given the required tools and materials.
- Criteria** Tasks must be performed within specifications, safety standards and time frames acceptable to industry.



**Line (GAC):**        **J**    **USE POWER SAWS**  
**Competency:**     **J1**   **Describe Power Saws**

**Objectives**

To be competent in this area, the individual must be able to:

- Describe power saws.
- Describe power saw applications.

**LEARNING TASKS**

**CONTENT**

1. Describe power saws

- Types
  - Band saw
  - Vertical
  - Horizontal
  - Cold saws
  - Reciprocating
  - Chop saw

2. Describe power saw applications

- Cut off
- Contour



**Line (GAC):** J    **USE POWER SAWS**  
**Competency:** J2    **Select and Maintain Band Saw Blades**

### Objectives

To be competent in this area, the individual must be able to:

- Select band saw blades.
- Weld and silver solder band saw blades.

### LEARNING TASKS

### CONTENT

- |                                |  |
|--------------------------------|--|
| 1.    Select band saw blades   | <ul style="list-style-type: none"><li>• Materials Type<ul style="list-style-type: none"><li>○ Thickness</li><li>○ Shape</li></ul></li><li>• Tooth selection</li><li>• Pitch selection<ul style="list-style-type: none"><li>○ Variable pitch</li></ul></li><li>• Blade types<ul style="list-style-type: none"><li>○ Bi-metal</li><li>○ Carbon</li></ul></li></ul> |
| 2.    Maintain band saw blades | <ul style="list-style-type: none"><li>• Butt weld</li><li>• Silver solder</li><li>• Storage procedures</li></ul>   |

### Achievement Criteria

**Performance**    The learner will be evaluated on the ability to:

- Select and maintain band saw blades

**Conditions**    As part of practical lab tasks, given the required tools and materials.

**Criteria**    Tasks must be performed within specifications, safety standards and time frames acceptable to industry.





**Line (GAC):**        **J**    **USE POWER SAWS**  
**Competency:**       **J3**   **Operate and Maintain Band Saws**

**Objectives**

To be competent in this area, the individual must be able to:

- Set speeds and feeds.
- Perform clamping.
- Install and remove blades.
- Operate and maintain band saws.
- Select cutting fluids for specific band saw applications.

**LEARNING TASKS**

**CONTENT**

- |                                 |  |
|---------------------------------|--|
| 1.    Set speeds and feeds      | <ul style="list-style-type: none"> <li>• Material <ul style="list-style-type: none"> <li>○ Type</li> <li>○ Size</li> <li>○ Profile</li> </ul> </li> <li>• Blade <ul style="list-style-type: none"> <li>○ Size</li> <li>○ Type</li> <li>○ Pitch</li> <li>○ Tooth style</li> <li>○ Tooth set</li> </ul> </li> </ul>  |
| 2.    Perform clamping          | <ul style="list-style-type: none"> <li>• Types <ul style="list-style-type: none"> <li>○ V-block</li> <li>○ Vices</li> <li>○ Fixtures</li> </ul> </li> </ul>  |
| 3.    Install and remove blades | <ul style="list-style-type: none"> <li>• Clamps and hold-downs</li> <li>• Blade <ul style="list-style-type: none"> <li>○ Inspection</li> <li>○ Direction</li> <li>○ Alignment</li> <li>○ Tension</li> <li>○ Break in procedures</li> <li>○ Coiling</li> </ul> </li> <li>• Guide selection</li> <li>• Clean guide wheels and guides</li> <li>• Cut-off</li> </ul> |



- |  |  |
|--|--|
| 4. Operate band saws   | <ul style="list-style-type: none"> <li>• Cut-off           <ul style="list-style-type: none"> <li>○ Speed and feed</li> <li>○ Power feed</li> <li>○ Coolants and lubricants</li> <li>○ Clamping</li> <li>○ Work support aids</li> </ul> </li> <li>Contour           <ul style="list-style-type: none"> <li>○ Speed and feed</li> <li>○ Power feed</li> <li>○ Coolants and lubricants</li> <li>○ Cutting aids</li> <li>○ Circle attachment</li> </ul> </li> <li>• Pusher</li> </ul> |
| 5. Maintain band saws  | <ul style="list-style-type: none"> <li>• Lubricate</li> <li>• Clean</li> <li>• Housekeeping</li> </ul>   |
| 6. Describe the purpose and usage of cutting fluids with band saws | <ul style="list-style-type: none"> <li>• Lubrication</li> <li>• Cooling</li> <li>• Chip removal</li> <li>• Tool life</li> </ul>  |
| 7. Select types of cutting fluids for applications                 | <ul style="list-style-type: none"> <li>• Types           <ul style="list-style-type: none"> <li>○ Straight oils</li> <li>○ Soluble oils</li> <li>○ Semi-synthetic</li> <li>○ Synthetic</li> <li>○ Misting</li> </ul> </li> </ul>   |

**Achievement Criteria**

**Performance** The learner will be evaluated on the ability to:

- Set speeds and feeds
- Perform clamping
- Install and remove blades
- Operate and maintain band saws
- Select cutting fluids for specific band saw application.

**Conditions** As part of practical lab tasks, given the required tools and materials.

**Criteria** Tasks must be performed within specifications, safety standards and time frames acceptable to industry.



**Line (GAC):** J **USE POWER SAWS**  
**Competency:** J4 **Operate and Maintain Other Saws**

**Objectives**

To be competent in this area, the individual must be able to:

- Operate and maintain cold saws.
- Operate and maintain abrasive chop saws.
- Operate and maintain reciprocating saws.

**LEARNING TASKS**

**CONTENT**

- |  |   |
|--|---|
| 1. Operate and maintain cold saws          | <ul style="list-style-type: none"> <li>• Set speeds</li> <li>• Work holding</li> <li>• Blade selection</li> <li>• Blade removal and installation</li> <li>• Operation</li> <li>• Maintenance               <ul style="list-style-type: none"> <li>○ Lubricate</li> <li>○ Clean</li> <li>○ Housekeeping</li> </ul> </li> </ul> |
| 2. Operate and maintain abrasive chop saws | <ul style="list-style-type: none"> <li>• Work holding</li> <li>• Wheel removal and installation</li> <li>• Operations</li> <li>• Maintenance               <ul style="list-style-type: none"> <li>○ Lubricate</li> <li>○ Clean</li> </ul> </li> <li>• Housekeeping</li> </ul>   |
| 3. Operate and maintain reciprocating saws | <ul style="list-style-type: none"> <li>• Set speeds</li> <li>• Work holding</li> <li>• Blade selection</li> <li>• Blade removal and installation</li> <li>• Operation</li> <li>• Maintenance               <ul style="list-style-type: none"> <li>○ Lubricate</li> <li>○ Clean</li> </ul> </li> <li>• Housekeeping</li> </ul> |



**Line (GAC):**        **K    USE LATHES**  
**Competency:**       **K1   Describe Lathes**

**Objectives**

To be competent in this area, the individual must be able to:

- Describe lathes and their applications.
- Identify parts of lathes and their functions.
- Describe lathe attachments.

**LEARNING TASKS**

**CONTENT**

1.    Describe lathes

- Types
  - Engine
  - Turret
  - Horizontal
  - Vertical
  - Chucking
  - Tracer
  - Tool room
  - Automatic
  - Single spindle
  - Multi spindle
  - Screw type
  - Swiss
  - C.N.C.
  - Metal spinning
- Size
  - Swing
  - Length

2.    Identify the parts of the lathe and their function

- Bed
  - Ways
  - Gap
- Headstock
  - Spindle
  - Speed change
  - Spindle nose style
- Feed system
  - Feed shaft
  - Lead screw
  - Change gears
  - Quick change gearbox



- Carriage
    - Saddle
    - Compound
    - Cross Slide
    - Apron
    - Thread chasing dial
    - Feed levers
  - Tailstock
    - Quill
    - Clamps
    - Adjustment
  - Chuck
    - Three-jaw
    - Four-jaw
    - Six-jaw
    - Collet
    - Magnetic
  
- 3. Describe lathe accessories
  - Face plate
  - Steady rest
  - Follower rest
  - Taper turning attachment
  - Radius cutting attachment
  - Tool post
    - American style
    - Square/Four-way box
    - Quick change
    - Boring bar holder
  
- 4. Describe lathe applications
  - Turning
  - Drilling
  - Boring
  - Threading
    - Internal
    - External
  - Facing
  - Tapers
  - Knurling
  - Contour
  - Profile
  - Parting
  - Spring winding
  - Radius turning



**Line (GAC):**        **K    USE LATHES**  
**Competency:**      **K2    Operate and Maintain Lathes**

**Objectives**

To be competent in this area, the individual must be able to:

- Operate and maintain lathes.
- Set speeds and feeds.
- Install and remove tooling.
- Select cutting fluids for specific lathe applications.

**LEARNING TASKS**

**CONTENT**

- |                                  |  |
|----------------------------------|--|
| 1.    Set speeds and feeds       | <ul style="list-style-type: none"> <li>• Calculations</li> </ul>   |
| 2.    Support work               | <ul style="list-style-type: none"> <li>• Material <ul style="list-style-type: none"> <li>○ Type</li> <li>○ Size</li> </ul> </li> <li>• Tool type</li> <li>• Rigidity</li> <li>• Power</li> <li>• Chucks or faceplates</li> <li>• Between centres--Drive dog</li> <li>• Steady rest/follower rest</li> </ul>  |
| 3.    Install and remove tooling | <ul style="list-style-type: none"> <li>• Select tool for application</li> <li>• Maintain tool</li> <li>• Tool height</li> <li>• Tool angle</li> </ul>  |
| 4.    Operate lathes             | <ul style="list-style-type: none"> <li>• Plan sequence of operation</li> <li>• Set-up sequence <ul style="list-style-type: none"> <li>○ Mounting workpiece</li> <li>○ Truing workpiece</li> <li>○ Balancing workpiece</li> <li>○ Centering workpiece</li> </ul> </li> <li>• Roughing <ul style="list-style-type: none"> <li>○ Speeds and feeds</li> <li>○ Cutters</li> <li>○ Depth of cut</li> <li>○ Measuring</li> <li>○ Material allowance for finishing</li> </ul> </li> <li>• Finishing</li> </ul> |



- Speeds and feeds
  - Cutter
  - Depth of cut
  - Deburring
  - Measuring
  - Operations
    - Turning
    - Drilling
    - Boring
    - Threading
    - Internal
    - External
    - Facing
    - Tapers
    - Knurling
    - Contour
    - Profile
    - Parting
    - Spring winding
    - Radius turning
  
- 5. Maintain lathes
  - Lubricate
  - Clean
  - Housekeeping
  
- 6. Describe the purpose and usage of cutting fluids with lathes
  - Lubrication
  - Cooling
  - Chip removal
  - Tool life
  
- 7. Select types of cutting fluids for applications
  - Types
    - Straight oils
    - Soluble oils
    - Semi-synthetic
    - Synthetic
    - Misting



**Achievement Criteria**

Performance The learner will be evaluated on the ability to:

- Operate and maintain lathes
- Set speeds and feeds
- Install and remove tooling
- Select cutting fluids for specific lathe applications

Conditions As part of practical lab tasks, given the required tools and materials.

Criteria Tasks must be performed within specifications, safety standards and time frames acceptable to industry.





**Line (GAC):**        **K    USE LATHES**  
**Competency:**      **K3    Cut Tapers**

**Objectives**

To be competent in this area, the individual must be able to:

- Describe tapers.
- Describe methods of cutting tapers.
- Cut and measure tapers.

**LEARNING TASKS**

**CONTENT**

- |   |   |
|---|---|
| <p>1.    Describe tapers</p>                    | <ul style="list-style-type: none"> <li>• Standard <ul style="list-style-type: none"> <li>○ Morse</li> <li>○ Brown and Sharpe</li> <li>○ Milling machine</li> </ul> </li> <li>• Non-standard</li> </ul>  |
| <p>2.    Describe methods of cutting tapers</p> | <ul style="list-style-type: none"> <li>• Internal</li> <li>• External</li> </ul>  |
| <p>3.    Calculate tapers</p>                   | <ul style="list-style-type: none"> <li>• Taper attachment <ul style="list-style-type: none"> <li>○ Plain</li> <li>○ Telescoping</li> </ul> </li> <li>• Compound slide</li> <li>• Tailstock offset</li> <li>• Taper angle</li> <li>• Taper per inch/foot</li> <li>• Taper (metric)</li> <li>• Calculate tailstock offset</li> </ul>  |
| <p>4.    Cut tapers</p>                         | <ul style="list-style-type: none"> <li>• Plan sequence of operation</li> <li>• Set-up sequence <ul style="list-style-type: none"> <li>○ Mounting workpiece</li> <li>○ Truing workpiece</li> <li>○ Balancing workpiece</li> <li>○ Centering workpiece</li> </ul> </li> <li>• Roughing <ul style="list-style-type: none"> <li>○ Speeds and feeds</li> <li>○ Tools</li> <li>○ Depth of cut</li> <li>○ Measuring</li> <li>○ Material allowance for finishing</li> </ul> </li> </ul> |



- Finishing
  - Speeds and feeds
  - Depth of cut
  - Deburring
  - Measuring
- Measuring
  - Gauge
  - Micrometer
  - Dial indicator

**Achievement Criteria**

Performance The learner will be evaluated on the ability to:

- Cut and measure tapers

Conditions As part of practical lab tasks, given the required tools and materials.

Criteria Tasks must be performed within specifications, safety standards and time frames acceptable to industry.



**Line (GAC):**        **M    USE SUPPORT MACHINES**  
**Competency:**      **M1   Operate and Maintain Hydraulic and Arbour Presses**

**Objectives**

To be competent in this area, the individual must be able to:

- Operate and maintain hydraulic and arbour presses.

**LEARNING TASKS**

**CONTENT**

- |                                  |  |
|----------------------------------|--|
| 1.    Operate hydraulic presses  | <ul style="list-style-type: none"> <li>• Safety precautions <ul style="list-style-type: none"> <li>○ Guards</li> <li>○ Personal protective equipment</li> <li>○ Housekeeping</li> </ul> </li> <li>• Press set-up <ul style="list-style-type: none"> <li>○ Work piece alignment</li> <li>○ Fixturing</li> <li>○ Table</li> <li>○ Adjustment</li> <li>○ Alignment</li> <li>○ Securement</li> <li>○ Ram positioning</li> </ul> </li> <li>• Relationship between force, pressure and area</li> </ul> |
| 2.    Maintain hydraulic presses | <ul style="list-style-type: none"> <li>• Hydraulics <ul style="list-style-type: none"> <li>○ Inspection</li> <li>○ Fluid levels</li> </ul> </li> <li>• Lubricate</li> <li>• Clean</li> <li>• Housekeeping</li> </ul>   |
| 3.    Operate arbour presses     | <ul style="list-style-type: none"> <li>• Safety precautions <ul style="list-style-type: none"> <li>○ Guards</li> <li>○ Personal protective equipment</li> <li>○ Housekeeping</li> </ul> </li> <li>• Press set-up <ul style="list-style-type: none"> <li>○ Work piece alignment</li> <li>○ Fixturing</li> </ul> </li> </ul>   |
| 4.    Maintain arbour presses    | <ul style="list-style-type: none"> <li>• Lubricate</li> <li>• Clean</li> <li>• Housekeeping</li> </ul>   |



**Achievement Criteria**

- Performance The learner will be evaluated on the ability to:
- Operate and maintain hydraulic and arbour presses
- Conditions As part of practical lab tasks, given the required tools and materials.
- Criteria Tasks must be performed within specifications, safety standards and time frames acceptable to industry.



**Line (GAC): N USE GRINDERS AND ABRASIVES**

**Competency: N1 Describe Types of Grinders**

**Objectives**

To be competent in this area, the individual must be able to:

- Describe types of grinders and their application.

**LEARNING TASKS**

**CONTENT**

1. Operate and maintain cold saws

- Set speeds
- Work holding
- Blade selection
- Blade removal and installation
- Operation
- Maintenance
  - Lubricate
  - Clean
  - Housekeeping



**Line (GAC):**        **N    USE GRINDERS AND ABRASIVES**

**Competency:**      **N2    Select Abrasives**

### Objectives

To be competent in this area, the individual must be able to:

- Describe abrasives and their applications.

### LEARNING TASKS

1.    Identify abrasives

2.    Describe abrasive applications

### CONTENT

- Aluminum dioxide
  - Silicon carbide
  - Cubic boron nitride (CBN)
  - Diamond
- 
- Grinding wheels



**Line (GAC):**        **N**    **USE GRINDERS AND ABRASIVES**  
**Competency:**      **N3**    **Operate and Maintain Grinders**

**Objectives**

To be competent in this area, the individual must be able to:

- Operate and maintain pedestal grinders.

**LEARNING TASKS**

**CONTENT**

1. Operate and maintain pedestal grinders

- Material
  - Type
  - Size
- Wheel selection
- Wheels mounting
- Wheel truing and dressing
- Maintenance
  - Cleaning
  - Lubricating
  - Housekeeping

**Achievement Criteria**

**Performance**    The learner will be evaluated on the ability to:

- Operate and maintain pedestal grinders

**Conditions**    As part of practical lab tasks, given the required tools and materials.

**Criteria**        Tasks must be performed within specifications, safety standards and time frames acceptable to industry.



**Line (GAC):**        **N**    **USE GRINDERS AND ABRASIVES**  
**Competency:**      **N4**    **Operate and Maintain Sanders and Polishers**

**Objectives**

To be competent in this area, the individual must be able to:

- Operate and maintain sanders and polishers.

**LEARNING TASKS**

**CONTENT**

- |  |  |
|--|--|
| 1. Describe sanders                                    | <ul style="list-style-type: none"> <li>• Types <ul style="list-style-type: none"> <li>○ Belt</li> <li>○ Disk</li> <li>○ Oscillating</li> </ul> </li> </ul>   |
| 2. Operate and maintain sanders                        | <ul style="list-style-type: none"> <li>• Abrasive installation <ul style="list-style-type: none"> <li>○ Belt</li> <li>○ Belt tensioning and alignment</li> <li>○ Disk</li> </ul> </li> <li>• Housekeeping</li> </ul> |
| 3. Describe the operation and maintenance of polishers | <ul style="list-style-type: none"> <li>• Types <ul style="list-style-type: none"> <li>○ Pedestal buffing wheel</li> </ul> </li> <li>• Select abrasives</li> <li>• Apply abrasive</li> <li>• Housekeeping</li> </ul>  |

**Achievement Criteria**

- Performance**    The learner will be evaluated on the ability to:
- Operate and maintain sanders and polishers
- Conditions**     As part of practical lab tasks, given the required tools and materials.
- Criteria**         Tasks must be performed within specifications, safety standards and time frames acceptable to industry.





# Level 2

# Machinist



**Line (GAC):** C **USE APPLIED MATHEMATICS**  
**Competency:** C1 **Solve Problems Involving Formulas**

**Objectives**

To be competent in this area, the individual must be able to:

- Perform calculations using formulas.

**LEARNING TASKS**

1. Use formulas

**CONTENT**

- Chords
- Pitch circles



**Line (GAC):** C USE APPLIED MATHEMATICS  
**Competency:** C7 Solve Problems Involving Trigonometry

### Objectives

To be competent in this area, the individual must be able to:

- Describe trigonometry applications.
- Apply trigonometry applications.

### LEARNING TASKS

1. Use applied trigonometry

### CONTENT

- Tapers
- Dovetails
- Layout procedures
  - Chords



**Line (GAC):**        **D    USE MEASURING TOOLS**

**Competency:**     **D3    Use Calipers and Gauges**

**Objectives**

To be competent in this area, the individual must be able to:

- Describe gauges.
- Use gauges.

**LEARNING TASKS**

**CONTENT**

1.    Describe gauges

- Types
  - Thread
  - Plug
  - Taper
  - Snap
  - Ring

2.    Use gauges

- Types
  - Thread
  - Plug
  - Taper
  - Snap
  - Ring

**Achievement Criteria**

**Performance**    The learner will be evaluated on the ability to:

- Demonstrate the use of the gauges listed

**Conditions**     As part of practical lab tasks, given the required tools and materials.

**Criteria**         Tasks must be performed within specifications, safety standards and time frames acceptable to industry.



**Line (GAC):**        **D    USE MEASURING TOOLS**  
**Competency:**      **D4   Use Dial Indicators and Digital Readouts**

**Objectives**

To be competent in this area, the individual must be able to:

- Describe dial indicators and their use.
- Use dial indicators.
- Describe digital readouts and their use.
- Use digital readouts.

**LEARNING TASKS**

**CONTENT**

- |  |  |
|--|--|
| <p>1.    Review dial indicators</p>    | <ul style="list-style-type: none"> <li>• Types and features <ul style="list-style-type: none"> <li>○ Clock type</li> <li>○ Finger type</li> </ul> </li> <li>• Graduations</li> <li>• Accessories</li> <li>• Uses <ul style="list-style-type: none"> <li>○ Comparing measurements</li> <li>○ Setting up</li> <li>○ Measuring</li> </ul> </li> <li>• Care and maintenance</li> </ul> |
| <p>2.    Use dial indicators</p>       | <ul style="list-style-type: none"> <li>• True workpiece <ul style="list-style-type: none"> <li>○ Milling machine</li> </ul> </li> <li>• Workpiece inspection</li> <li>• Care and maintenance</li> </ul>  |
| <p>3.    Describe digital readouts</p> | <ul style="list-style-type: none"> <li>• Types <ul style="list-style-type: none"> <li>○ Manual</li> <li>○ Programmable</li> </ul> </li> <li>• Parts</li> <li>• Uses <ul style="list-style-type: none"> <li>○ Lathe</li> <li>○ Milling machine</li> </ul> </li> <li>• Care and maintenance</li> </ul>   |



## 4. Use digital readouts

- Presets
- Types
  - Manual
  - Programmable
- Uses
  - Lathe
  - Milling machine
- Care and maintenance

**Achievement Criteria**

Performance The learner will be evaluated on the ability to:

- Use dial indicators
- Use digital readouts

Conditions As part of practical lab tasks, given the required tools and materials.

Criteria Tasks must be performed within specifications, safety standards and time frames acceptable to industry.



**Line (GAC):** E **INTERPRET DRAWINGS AND REFERENCE MATERIALS**  
**Competency:** E3 **Use Machinery's Handbook and Other Reference Materials**

**Objectives**

To be competent in this area, the individual must be able to:

- Identify information found in the Machinery's Handbook.
- Locate information in the Machinery's Handbook.

**LEARNING TASKS**

**CONTENT**

- |  |  |
|--|--|
| <ol style="list-style-type: none"> <li>1. Identify information found in the Machinery's Handbook</li> <li>2. Locate information in the Machinery's Handbook</li> <li>3. Use other reference materials</li> </ol> | <ul style="list-style-type: none"> <li>• Types             <ul style="list-style-type: none"> <li>○ Materials</li> </ul> </li> <li>• Material information</li> <li>• Advanced thread data</li> <li>• Fits and tolerances</li> <li>• Formulas</li> <li>• Speeds and feeds</li> <li>• Job plan             <ul style="list-style-type: none"> <li>○ machine limitations</li> </ul> </li> <li>• Quality Control Documentation             <ul style="list-style-type: none"> <li>○ Inspection sheets</li> <li>○ Blueprints</li> </ul> </li> </ul> |
|--|--|

**Line E: INTERPRET DRAWINGS AND REFERENCE MATERIALS****Competency: E4 Describe Fits and Tolerances****Objectives**

To be competent in this area, the individual must be able to:

- Describe geometric dimensions and tolerances.

**LEARNING TASKS**

1. Describe geometric dimensions and tolerances

**CONTENT**

- Application
  - Concentricity
  - Roundness
  - Parallelism
  - Angularity
  - Line and surface
  - Flatness
  - Perpendicularity
  - Roundness
  - Runout
  - Total runout
  - Datums
  - Profiler





**Line (GAC):** F **SELECT MATERIALS**  
**Competency:** F1 **Describe Principles of Metallurgy**

**Objectives**

To be competent in this area, the individual must be able to:

- Describe the raw resources used in the manufacture of iron and steel.
- Describe the manufacture of iron and steel.

**LEARNING TASKS**

**CONTENT**

- |  |   |
|--|---|
| <p>1. Describe smelting process</p>              | <ul style="list-style-type: none"> <li>• Coke</li> <li>• Iron ores</li> <li>• Limestone</li> <li>• Process</li> <li>• Blast furnace</li> </ul>  |
| <p>2. Describe steel manufacturing processes</p> | <ul style="list-style-type: none"> <li>• Furnace types             <ul style="list-style-type: none"> <li>○ Basic oxygen</li> <li>○ Pig iron</li> <li>○ Scrap steel</li> <li>○ Open hearth</li> <li>○ Pig iron</li> <li>○ Limestone</li> <li>○ Natural gas</li> <li>○ Electric                 <ul style="list-style-type: none"> <li>– Induction                     <ul style="list-style-type: none"> <li>* Scrap steel</li> </ul> </li> <li>– Arc                     <ul style="list-style-type: none"> <li>* Pig iron</li> <li>* Limestone</li> <li>* Scrap steel</li> </ul> </li> </ul> </li> </ul> </li> <li>• Carbon</li> <li>• Additional alloys</li> </ul> |



**Line (GAC):** F **SELECT MATERIALS**  
**Competency:** F2 **Describe Characteristics of Ferrous Metals**

**Objectives**

To be competent in this area, the individual must be able to:

- Describe the SAE and AISI classifications.
- Identify steel characteristics by their designations.

**LEARNING TASKS**

**CONTENT**

- |   |   |
|---|---|
| <p>1. Describe Society of Automotive Engineers (SAE) and American Iron and Steel Institute (AISI) classifications</p> | <ul style="list-style-type: none"> <li>• Plain carbon steels</li> <li>• Standard alloy steels</li> <li>• Tool steels</li> <li>• Stainless steels</li> <li>• Numbering system</li> </ul>   |
| <p>2. Identify steel characteristics by their designations</p>  | <ul style="list-style-type: none"> <li>• Carbon content</li> <li>• Alloying elements</li> <li>• Physical properties:               <ul style="list-style-type: none"> <li>○ Wear resistance</li> <li>○ Weight</li> <li>○ Flexibility</li> <li>○ Hardness</li> <li>○ Toughness</li> <li>○ Corrosion resistance</li> <li>○ Ductility</li> <li>○ Machinability</li> <li>○ Conductivity</li> <li>○ Thermal</li> <li>○ Electrical</li> </ul> </li> <li>• Applications</li> </ul> |



**Line (GAC):** F **SELECT MATERIALS**  
**Competency:** F3 **Describe Characteristics of Non-ferrous Metals**

**Objectives**

To be competent in this area, the individual must be able to:

- Describe the characteristics of non-ferrous metals.

**LEARNING TASKS**

**CONTENT**

- |   |   |
|---|---|
| <p>1. Describe the classification of aluminum alloys</p>    | <ul style="list-style-type: none"> <li>• Designations               <ul style="list-style-type: none"> <li>○ Alloys</li> <li>○ Temper</li> </ul> </li> <li>• Physical properties               <ul style="list-style-type: none"> <li>○ Wear resistance</li> <li>○ Weight</li> <li>○ Flexibility</li> <li>○ Hardness</li> <li>○ Toughness</li> <li>○ Corrosion resistance</li> <li>○ Ductility</li> <li>○ Machinability</li> <li>○ Conductivity</li> <li>○ Thermal</li> <li>○ Electrical</li> </ul> </li> <li>• Applications</li> </ul> |
| <p>2. Describe the UNS classifications of copper alloys</p> | <ul style="list-style-type: none"> <li>• Alloys</li> <li>• Physical properties               <ul style="list-style-type: none"> <li>○ Wear resistance</li> <li>○ Weight</li> <li>○ Flexibility</li> <li>○ Hardness</li> <li>○ Toughness</li> <li>○ Corrosion resistance</li> <li>○ Ductility</li> <li>○ Machinability</li> <li>○ Conductivity</li> <li>○ Thermal</li> <li>○ Electrical</li> </ul> </li> </ul>   |



- Heat treatment
  - Applications
    - Electrical components
    - Brass
    - Ornamental castings
    - Bronze
    - Bearings
  - Physical properties
    - Wear resistance
    - Weight
    - Flexibility
    - Hardness
    - Toughness
    - Corrosion resistance
    - Ductility
    - Machinability
    - Conductivity
    - Thermal
    - Electrical
  
- 3. Describe the characteristics of other non-ferrous metals
  - Designations
    - Alloys
    - Temper
  - Physical properties
    - Wear resistance
    - Weight
    - Flexibility
    - Hardness
    - Toughness
    - Corrosion resistance
    - Ductility
    - Machinability
    - Conductivity
    - Thermal
    - Electrical
  - Heat treatment
  - Applications



**Line (GAC):** F **SELECT MATERIALS**  
**Competency:** F4 **Describe Characteristics of Non-metals**

**Objectives**

To be competent in this area, the individual must be able to:

- Describe the characteristics of non-metals.

**LEARNING TASKS**

**CONTENT**

- |                                 |  |
|---------------------------------|--|
| <p>1. Describe plastics</p>     | <ul style="list-style-type: none"> <li>• Types               <ul style="list-style-type: none"> <li>○ Thermoplastic</li> <li>○ Thermoset</li> </ul> </li> <li>• Physical properties               <ul style="list-style-type: none"> <li>○ Wear resistance</li> <li>○ Weight</li> <li>○ Flexibility</li> <li>○ Hardness</li> <li>○ Toughness</li> <li>○ Ductility</li> <li>○ Machinability</li> <li>○ Conductivity</li> <li>○ Thermal</li> <li>○ Electrical</li> </ul> </li> <li>• Applications</li> </ul> |
| <p>2. Describe rubbers</p>      | <ul style="list-style-type: none"> <li>• Types</li> <li>• Applications</li> </ul>  |
| <p>3. Describe lignum vitae</p> | <ul style="list-style-type: none"> <li>• Types</li> <li>• Applications</li> </ul>  |



**Line (GAC):** F **SELECT MATERIALS**  
**Competency:** F8 **Describe the Use and Maintenance of Fuel Gas Equipment**

**Objectives**

To be competent in this area, the individual must be able to:

- Describe the safe operation and maintenance of fuel gas equipment.

**LEARNING TASKS**

**CONTENT**

1. Describe the operation and maintenance of fuel gas equipment

- Safety considerations
- System set-up
- Torch Operations
  - Welding
  - Cutting
  - Soldering
  - Brazing
- Oxyacetylene and MAPP gas
  - Flashback arrestors
  - Regulators
- Propane
  - Liquid and gas
  - Temperature
  - Ventilation
- Maintenance of fuel gas equipment
- Storage of fuel gas equipment
  - Recognizing worn, damaged or defective fuel gas equipment



**Line (GAC): G PLAN SEQUENCE OF OPERATION**

**Competency: G1 Determine Project Requirements**

### Objectives

To be competent in this area, the individual must be able to:

- Determine project requirements from a drawing or sample.
- Plan the manufacturing sequences.

### LEARNING TASKS

### CONTENT

- |   |  |
|---|--|
| <p>1. Describe the sequence of milling operations</p> | <ul style="list-style-type: none"> <li>• Material requirements               <ul style="list-style-type: none"> <li>○ Types</li> <li>○ Machining allowances</li> </ul> </li> <li>• Machine tool               <ul style="list-style-type: none"> <li>○ Rough stock preparation</li> <li>○ Machining</li> </ul> </li> <li>• Select tooling</li> <li>• Optional processes               <ul style="list-style-type: none"> <li>○ Welding</li> <li>○ Heat treatment</li> <li>○ Plating</li> </ul> </li> <li>• Inspection</li> </ul> |
| <p>2. Plan the manufacturing sequence</p>             | <ul style="list-style-type: none"> <li>• Milling               <ul style="list-style-type: none"> <li>○ Square up block</li> <li>○ Key seating</li> <li>○ Helical</li> <li>○ Spline</li> </ul> </li> <li>• Heat treatment               <ul style="list-style-type: none"> <li>○ Harden</li> <li>○ Temper</li> </ul> </li> </ul>   |

### Achievement Criteria

**Performance** The learner will be evaluated on the ability to:

- Determine project requirements from a drawing or sample
- Plan manufacturing sequences

**Conditions** As part of practical lab tasks, given the required tools and materials.

**Criteria** Tasks must be performed within specifications, safety standards and time frames acceptable to industry.



**Line (GAC):**      K    **USE LATHES**

**Competency:**    K4   **Cut Threads**

### Objectives

To be competent in this area, the individual must be able to:

- Describe threads.
- Describe methods of threading.
- Calculate imperial threads.
- Cut and measure imperial threads.

### LEARNING TASKS

1. Describe threads

2. Describe methods of threading

### CONTENT

- Types
  - Standard
    - Unified
    - Metric
    - Acme
    - Pipe
    - Whitworth
  - Non-standard
    - Multiple start
- Theory
  - Angle
  - Pitch
  - Lead
  - Thread form
  - Lead angle
- Measurement
  - Three-wire
  - Nut
  - Snap gauge
  - Micrometer
- Internal
  - Compound offset
  - Compound (90 degrees)
  - Graduation
  - Tapping
  - Tapered (NPT)





- External
    - Compound offset
    - Compound (90 degrees)
    - Graduation
    - Dies
    - Tapered (NPT)
  
- 3. Calculate threads
  - Pitch
  - Lead
  - Depth of thread
  - Angle
  - Minor diameter
  - Major diameter
  - Three-wire
  
- 4. Cut imperial threads
  - Plan sequence of operation
    - Engagement points
    - Speeds, feed and pitch
    - Tool choice
    - Tool alignment
  - Set-up sequence
    - Mounting workpiece
    - Truing workpiece
    - Balancing workpiece
    - Centering workpiece
  - Roughing
    - Depth of cut
    - Measuring
    - Material allowance for finishing
  - Finishing
    - Depth of cut
    - Deburring
    - Measuring
  - Measuring
    - Gauge
    - Micrometer
    - Three-wire



**Achievement Criteria**

Performance The learner will be evaluated on the ability to:

- Calculate imperial threads
- Cut and measure imperial threads

Conditions As part of practical lab tasks, given the required tools and materials.

Criteria Tasks must be performed within specifications, safety standards and time frames acceptable to industry.



**Line (GAC):**        **K    USE LATHES**  
**Competency:**     **K5   Describe the Use of Advanced Cutting Tools**

### Objectives

To be competent in this area, the individual must be able to:

- Describe the use of advanced cutting tools.

### LEARNING TASKS

1. Describe the use of advanced cutting tools

### CONTENT

- Types
  - Indexable insert
  - Ceramic
  - CBN
  - Cermet
- Shape
- Dimensions
- Positioning
- Installation techniques
- Holders
  - Feed Rate RPMs



**Line (GAC):** L **USE MILLING MACHINES**  
**Competency:** L1 **Describe Milling Machines**

**Objectives**

To be competent in this area, the individual must be able to:

- Describe milling machines and their accessories.
- Describe the parts of milling machines.
- Describe tool holding devices.
- Describe work holding devices.
- Describe milling applications.

**LEARNING TASKS**

**CONTENT**

1. Describe milling machines

- Vertical Spindle
  - Ram type
  - Ram turret
  - Gear head
- Horizontal Spindle
  - Plain
  - Universal
- Planer mill
- Computer controlled
- Multi-spindle
- Manufacturing types
- Size

2. Identify the parts of the milling machine and their function

- Base
- Column
- Spindle nose
- Table
- Saddle
- Knee
- Backlash eliminator
- Rapid traverse
- Over arm support



- 3. Describe milling machine accessories
  - Rotary table
  - Dividing head
  - Rack milling attachments
  - Vertical milling heads
    - Plain
    - Universal
  - Slotter
  - High speed spindle
  
- 4. Describe work holding devices
  - Clamp and hold-downs
  - Vises
    - Plain
    - Swivel
    - Compound
  - Dividing heads
    - Plain
    - Universal
  - Rotary table
  - Sine table
  - Fixtures
  - Angle plates
  - V-blocks
  
- 5. Describe milling machine applications
  - Mill
    - Flat surfaces
    - Shapes
    - Keyways
    - Slots
    - Drill
    - Ream
    - Bore
    - Counter bore
    - Counter sink
    - Spot face
    - Angles
    - Radii
    - Dovetails
    - Gears and racks
    - Helical contours
    - Gang milling
    - Straddle milling
  - Indexing heads
  - Rotary tables





3. Describe tool holding devices

- Arbours
  - Styles A, B and C
- Adapters
  - End mill
  - Morse taper
  - Collet
  - Quick change
- Boring heads
  - Plain
  - Facing
  - Grooving



**Line (GAC):** L **USE MILLING MACHINES**  
**Competency:** L3 **Use Dividing Heads and Rotary Tables**

### Objectives

To be competent in this area, the individual must be able to:

- Describe dividing heads and rotary tables.
- Use dividing heads and rotary tables.

### LEARNING TASKS

1. Describe dividing heads

2. Use dividing heads

### CONTENT

- Universal dividing heads
- Indexing
  - Direct
  - Simple
  - Angular
  - Differential
- Construction
  - Hole plates
  - Chuck
  - Centre
  - Foot stock
  - Head/gear ratio
- Applications
  - Milling
    - Hexagons
    - Keyways
- Plan sequence of operation
- Angular alignment
- Linear alignment
- Calculate indexing situation
- Select circle on hole plate
- Select number of rotations and divisions
- Set sector arms
- Clamp





- 3. Describe rotary tables
  - Indexing
    - Direct
    - Simple
    - Angular
  - Construction
    - Hole plates
    - Chuck
    - Head/gear ratio
    - Angular increments
  - Applications
    - Milling
      - Contours
      - Drilling hole patterns
      - Radii
  
- 4. Use rotary tables
  - Plan sequence of operation
  - Workpiece assignment
  - Milling spindle alignment
  - Cutter offset
  - Fixtures
  - Calculate indexing situation
  - Indexed table
    - Select circle on hole plate
    - Select number of rotations and divisions
  - Clamp

**Achievement Criteria**

- Performance** The learner will be evaluated on the ability to:
- Use dividing heads and rotary tables
- Conditions** As part of practical lab tasks, given the required tools and materials.
- Criteria** Tasks must be performed within specifications, safety standards and time frames acceptable to industry.



**Line (GAC):** L **USE MILLING MACHINES**  
**Competency:** L4 **Operate and Maintain Milling Machines**

### Objectives

To be competent in this area, the individual must be able to:

- Operate and maintain milling machines.
- Set speeds and feeds.
- Install and remove tooling.
- Select cutting fluids for specific milling applications.

### LEARNING TASKS

### CONTENT

- |                               |  |
|-------------------------------|--|
| 1. Set speeds and feeds       | <ul style="list-style-type: none"> <li>• Calculations</li> <li>• Material               <ul style="list-style-type: none"> <li>○ Type</li> </ul> </li> <li>• Cutter type</li> <li>• Cutter size</li> <li>• Rigidity</li> <li>• Power</li> </ul>  |
| 2. Secure the work            | <ul style="list-style-type: none"> <li>• Clamp and hold-downs</li> <li>• Vises               <ul style="list-style-type: none"> <li>○ Plain</li> <li>○ Swivel</li> <li>○ Compound</li> </ul> </li> <li>• Dividing heads               <ul style="list-style-type: none"> <li>○ Plain</li> <li>○ Universal</li> </ul> </li> <li>• Rotary table</li> <li>• Sine table</li> <li>• Fixtures</li> <li>• Angle plates</li> <li>• V-blocks</li> </ul> |
| 3. Install and remove tooling | <ul style="list-style-type: none"> <li>• Select cutter and holder for application</li> <li>• Maintain cutter and holder               <ul style="list-style-type: none"> <li>○ Clean and lubricate</li> </ul> </li> </ul>  |



4. Operate milling machines

- Plan sequence of operation
- Align machine
  - Spindle alignment
  - Table alignment
  - Accessory alignment
- Set-up sequence
  - Mounting workpiece
  - Aligning workpiece
- Climb verses conventional
- Roughing
  - Speeds and feeds
  - Cutters
  - Depth of cut
  - Measuring
  - Material allowance for finishing
- Finishing
  - Speeds and feeds
  - Cutters
  - Depth of cut
  - Deburring
  - Measuring
- Operations
  - Mill
    - Flat surfaces
    - Shapes
    - Keyways
    - Slots
    - Drill
    - Ream
    - Bore
    - Counter bore
    - Counter sink
    - Spot face
    - Angles
    - Straddle milling
  - Indexing heads
  - Rotary tables

5. Maintain milling machines

- Lubricate
- Clean
- Housekeeping



- |    |  |  |
|----|--|--|
| 6. | Describe the purpose and usage of cutting fluids with milling machines | <ul style="list-style-type: none"> <li>• Lubrication</li> <li>• Cooling</li> <li>• Chip removal</li> <li>• Tool life</li> </ul>  |
| 7. | Select types of cutting fluids for specific applications               | <ul style="list-style-type: none"> <li>• Types               <ul style="list-style-type: none"> <li>○ Straight oils</li> <li>○ Soluble oils</li> <li>○ Semi-synthetic</li> <li>○ Synthetic</li> <li>○ Misting</li> </ul> </li> </ul> |

**Achievement Criteria**

**Performance** The learner will be evaluated on the ability to:

- Operate and maintain milling machines
- Set speeds and feeds
- Install and remove tooling
- Select cutting fluids for specific milling applications

**Conditions** As part of practical lab tasks, given the required tools and materials.

**Criteria** Tasks must be performed within specifications, safety standards and time frames acceptable to industry.



**Line (GAC):**        **N    USE GRINDERS AND ABRASIVES**  
**Competency:**      **N2    Select Abrasives**

**Objectives**

To be competent in this area, the individual must be able to:

- Describe the Standard Marking System.

**LEARNING TASKS**

**CONTENT**

1. Describe the Standard Marking System

- Grit
- Grit size
- Hardness
- Structure
  - Bond



# Level 3

# Machinist



**Line (GAC):** C USE APPLIED MATHEMATICS  
**Competency:** C2 Solve Problems Involving Ratios

### Objectives

To be competent in this area, the individual must be able to:

- Calculate ratios.

### LEARNING TASKS

1. Apply ratios

### CONTENT

- Pulley
- Gear
- Mechanical advantage
  - Levers
  - Wedges
  - Screws



**Line (GAC):** C USE APPLIED MATHEMATICS  
**Competency:** C7 Solve Problems Involving Trigonometry

### Objectives

To be competent in this area, the individual must be able to:

- Describe trigonometry applications.
- Apply trigonometry applications.

### LEARNING TASKS

1. Use applied trigonometry

### CONTENT

- Co-ordinates
- Layout procedures





**Line (GAC):**        **D    USE MEASURING TOOLS**

**Competency:**     **D3    Use Calipers and Gauges**

**Objectives**

To be competent in this area, the individual must be able to:

- Describe gauge blocks.
- Use gauge blocks.

**LEARNING TASKS**

**CONTENT**

- |                             |  |
|-----------------------------|--|
| 1.    Describe gauge blocks | <ul style="list-style-type: none"> <li>• Types</li> <li>• Materials</li> <li>• Grades</li> </ul>   |
| 2.    Use gauge blocks      | <ul style="list-style-type: none"> <li>• Care and cleaning</li> <li>• Calculate combinations</li> <li>• Wear blocks</li> <li>• Wringing</li> </ul> |

**Achievement Criteria**

Performance    The learner will be evaluated on the ability to:

- Use gauge blocks

Conditions      As part of practical lab tasks, given the required tools and materials.

Criteria          Tasks must be performed within specifications, safety standards and time frames acceptable to industry.



**Line (GAC):** D **USE MEASURING TOOLS**  
**Competency:** D4 **Use Dial Indicators and Digital Readouts**

### Objectives

To be competent in this area, the individual must be able to:

- Use dial indicators.
- Use digital readouts.

### LEARNING TASKS

1. Use dial indicators
  
2. Use digital readouts

### CONTENT

- True workpiece
  - Grinders
- Workpiece inspection
- Care and maintenance
  
- Presets
- Types
  - Manual
  - Programmable
- Uses
  - Lathe
  - Milling machine
- Care and maintenance

### Achievement Criteria

**Performance** The learner will be evaluated on the ability to:

- Use and maintain dial indicators
- Use digital readouts

**Conditions** As part of practical lab tasks, given the required tools and materials.

**Criteria** Tasks must be performed within specifications, safety standards and time frames acceptable to industry.



**Line (GAC):** E **INTERPRET DRAWINGS AND REFERENCE MATERIALS**  
**Competency:** E3 **Use Machinery’s Handbook and Other Reference Materials**

**Objectives**

To be competent in this area, the individual must be able to:

- Identify information found in the Machinery’s Handbook.
- Locate information in the Machinery’s Handbook.

**LEARNING TASKS**

**CONTENT**

<ol style="list-style-type: none"> <li>1. Identify information found in the Machinery’s Handbook</li> <li>2. Locate information in the Machinery’s Handbook</li> <li>3. Use other reference materials</li> </ol>	<ul style="list-style-type: none"> <li>• Types               <ul style="list-style-type: none"> <li>○ Gears</li> </ul> </li> <li>• Formulas</li> <li>• Speeds and feeds</li> <li>• Job plan</li> <li>• Quality control documentation               <ul style="list-style-type: none"> <li>○ Inspection sheets</li> <li>○ Blueprints</li> </ul> </li> </ul>
--	--

**Achievement Criteria**

Performance	The learner will be evaluated on the ability to: <ul style="list-style-type: none"> <li>• Identify and locate information in the Machinery’s handbook</li> </ul>
Conditions	As part of practical lab tasks, given the required tools and materials.
Criteria	Tasks must be performed within specifications, safety standards and time frames acceptable to industry.



**Line F:                 SELECT MATERIALS**

**Competency:         F2   Describe Characteristics of Ferrous Metals**

**Objectives**

To be competent in this area, the individual must be able to:

- Describe the SAE and AISI classifications.
- Identify steel characteristics by their designations.

**LEARNING TASKS**

**CONTENT**

- |   |   |
|---|---|
| <ol style="list-style-type: none"> <li>1.    Review the Society of Automotive Engineers (SAE) and American Iron and Steel Institute (AISI) classifications</li> <br/> <li>2.    Identify steel characteristics for particular applications by their designations</li> </ol> | <ul style="list-style-type: none"> <li>• Plain carbon steels</li> <li>• Standard alloy steels</li> <li>• Tool steels</li> <li>• Stainless steels</li> <li>• Numbering system</li> <br/> <li>• Carbon content</li> <li>• Alloying elements</li> <li>• Physical properties: <ul style="list-style-type: none"> <li>○ Wear resistance</li> <li>○ Weight</li> <li>○ Flexibility</li> <li>○ Hardness</li> <li>○ Toughness</li> <li>○ Corrosion resistance</li> <li>○ Ductility</li> <li>○ Machinability</li> <li>○ Conductivity <ul style="list-style-type: none"> <li>– Thermal</li> <li>– Electrical</li> </ul> </li> </ul> </li> <li>• Specific applications</li> </ul> |
|---|---|



**Line (GAC):** F **SELECT MATERIALS**  
**Competency:** F3 **Describe Characteristics of Non-ferrous Metals**

### Objectives

To be competent in this area, the individual must be able to:

- Describe the characteristics of non-ferrous metals.

### LEARNING TASKS

1. Review the classification of aluminum alloys for specific applications

### CONTENT

- Designations
  - Alloys
  - Temper
- Physical properties
  - Wear resistance
  - Weight
  - Flexibility
  - Hardness
  - Toughness
  - Corrosion resistance
  - Ductility
  - Machinability
  - Conductivity
    - Thermal
    - Electrical
- Specific applications
  - Electrical components
  - Die castings



2. Review the UNS classifications of copper alloys
  - Alloys
  - Physical properties
    - Wear resistance
    - Weight
    - Flexibility
    - Hardness
    - Toughness
    - Corrosion resistance
    - Ductility
    - Machinability
    - Conductivity
      - Thermal
      - Electrical
  - Heat treatment
  - Applications
    - Electrical components
    - Brass
      - Ornamental castings
    - Bronze
      - Bearings
  
3. Review the characteristics of other non-ferrous metals
  - Material selection
    - Babbitt
    - Lead
    - Nickel
    - Tin
    - Titanium
  - Physical properties
    - Wear resistance
    - Weight
    - Flexibility
    - Hardness
    - Toughness
    - Corrosion resistance
    - Ductility
    - Machinability
    - Conductivity
      - Thermal
      - Electrical



**Line (GAC):** F **SELECT MATERIALS**  
**Competency:** F4 **Describe Characteristics of Non-metals**

**Objectives**

To be competent in this area, the individual must be able to:

- Describe the characteristics of non-metals.

**LEARNING TASKS**

**CONTENT**

- |                               |  |
|-------------------------------|--|
| <p>1. Review plastics</p>     | <ul style="list-style-type: none"> <li>• Types               <ul style="list-style-type: none"> <li>○ Thermoplastic</li> <li>○ Thermoset</li> </ul> </li> <li>• Physical properties               <ul style="list-style-type: none"> <li>○ Wear resistance</li> <li>○ Weight</li> <li>○ Flexibility</li> <li>○ Hardness</li> <li>○ Toughness</li> <li>○ Ductility</li> <li>○ Machinability</li> <li>○ Conductivity                   <ul style="list-style-type: none"> <li>– Thermal</li> <li>– Electrical</li> </ul> </li> </ul> </li> <li>• Applications</li> </ul> |
| <p>2. Review rubbers</p>      | <ul style="list-style-type: none"> <li>• Types</li> <li>• Applications</li> </ul>  |
| <p>3. Review lignum vitae</p> | <ul style="list-style-type: none"> <li>• Types</li> <li>• Applications</li> </ul>  |



**Line (GAC):** F **SELECT MATERIALS**  
**Competency:** F5 **Select Materials for Applications**

**Objectives**

To be competent in this area, the individual must be able to:

- Select materials for applications.

**LEARNING TASKS**

**CONTENT**

1. Describe considerations when selecting materials for applications

- Physical properties
  - Wear resistance
  - Weight
  - Flexibility
  - Hardness
  - Toughness
  - Ductility
  - Machinability
  - Strength
  - Corrosion resistance
  - Suitable for casting
  - Conductivity
    - Thermal
    - Electrical
- Cost
- Availability

**Achievement Criteria**

**Performance** The learner will be evaluated on the ability to:

- Select correct materials for specific applications

**Conditions** As part of practical lab tasks, given the required tools and materials.

**Criteria** Tasks must be performed within specifications, safety standards and time frames acceptable to industry.





**Line (GAC):** F **SELECT MATERIALS**  
**Competency:** F6 **Describe and Perform Heat Treating**

**Objectives**

To be competent in this area, the individual must be able to:

- Describe heat treating and surface treatment.
- Perform heat treating processes.

**LEARNING TASKS**

**CONTENT**

- |                                    |  |
|------------------------------------|--|
| 1. Describe surface treatments     | <ul style="list-style-type: none"> <li>• Plating               <ul style="list-style-type: none"> <li>○ Chrome</li> <li>○ Gold</li> <li>○ Nickel</li> <li>○ Brass</li> <li>○ Copper</li> </ul> </li> <li>• Anodizing</li> <li>• Bluing</li> <li>• Spray welding</li> </ul> |
| 2. Describe heat treating          | <ul style="list-style-type: none"> <li>• Case hardening</li> <li>• Through hardening</li> <li>• Normalizing</li> <li>• Annealing</li> <li>• Flame hardening</li> <li>• Induction hardening</li> <li>• Tempering</li> </ul>   |
| 3. Perform heat treating processes | <ul style="list-style-type: none"> <li>• Normalizing</li> <li>• Annealing</li> <li>• Flame hardening</li> <li>• Induction hardening</li> <li>• Tempering</li> </ul>  |
| 4. Review oxy-acetylene processes  | <ul style="list-style-type: none"> <li>• Safety</li> <li>• System set-up</li> <li>• Torch operation               <ul style="list-style-type: none"> <li>○ Heating</li> <li>○ Heat treating</li> </ul> </li> </ul>   |



**Achievement Criteria**

Performance The learner will be evaluated on the ability to:

- Perform heat treating processes

Conditions As part of practical lab tasks, given the required tools and materials.

Criteria Tasks must be performed within specifications, safety standards and time frames acceptable to industry.



**Line (GAC):**        **F    SELECT MATERIALS**  
**Competency:**     **F7   Describe Materials Testing**

**Objectives**

To be competent in this area, the individual must be able to:

- Describe the physical properties and characteristics of steel.
- Perform hardness testing.

**LEARNING TASKS**

**CONTENT**

- |  |  |
|--|--|
| <ol style="list-style-type: none"> <li>1. Describe the physical properties and characteristics of steel</li> <li>2. Perform hardness tests</li> <li>3. Describe non-destructive testing</li> </ol> | <ul style="list-style-type: none"> <li>• Hardness</li> <li>• Tensile strength</li> <li>• Shear strength</li> <li>• Rockwell</li> <li>• Brinell</li> <li>• Dye penetrant tests</li> </ul> |
|--|--|

**Achievement Criteria**

**Performance**    The learner will be evaluated on the ability to:

- Conduct Rockwell and Brinell hardness tests

**Conditions**     As part of practical lab tasks, given the required tools and materials.

**Criteria**         Tasks must be performed with 100% accuracy.



**Line (GAC): G PLAN SEQUENCE OF OPERATION**

**Competency: G1 Determine Project Requirements**

**Objectives**

To be competent in this area, the individual must be able to:

- Determine project requirements from a complex drawing or sample.
- Plan the manufacturing sequences.

**LEARNING TASKS**

**CONTENT**

1. Review the sequence of manufacturing operations

- Material requirements
  - Types
  - Machining allowances
- Machine tool
  - Rough stock preparation
  - Machining
- Select tooling
- Optional processes
  - Welding
  - Heat treatment
  - Plating
- Inspection

2. Plan manufacturing sequence

- Lathes
  - Metric threading
- Cylindrical grinding
  - Parallel shafts
  - Taper shafts
- Surface grinding
  - Finish two sides

**Achievement Criteria**

**Performance** The learner will be evaluated on the ability to:

- Plan manufacturing sequences

**Conditions** As part of practical lab tasks, given the required tools and materials.

**Criteria** Tasks must be performed within specifications, safety standards and time frames acceptable to industry.



**Line (GAC):** H **DESCRIBE FABRICATION AND ASSEMBLY**  
**Competency:** H3 **Describe Bearings, Seals and Bearing Materials**

**Objectives**

To be competent in this area, the individual must be able to:

- Describe bearings, seals and bearing materials.

**LEARNING TASKS**

**CONTENT**

- |  |  |
|--|--|
| 1. Describe bearings                   | <ul style="list-style-type: none"> <li>• Types of bearings               <ul style="list-style-type: none"> <li>○ Friction</li> <li>○ Anti-friction</li> </ul> </li> <li>• Principles of operation               <ul style="list-style-type: none"> <li>○ Sliding</li> <li>○ Rolling</li> </ul> </li> <li>• Types of loads               <ul style="list-style-type: none"> <li>○ Radial</li> <li>○ Thrust</li> <li>○ Combination</li> </ul> </li> </ul> |
| 2. Describe friction bearings          | <ul style="list-style-type: none"> <li>• Types               <ul style="list-style-type: none"> <li>○ Bushing</li> <li>○ Sleeve</li> <li>○ Split</li> </ul> </li> <li>• Housing styles               <ul style="list-style-type: none"> <li>○ Flange</li> <li>○ Pillow block</li> </ul> </li> </ul>  |
| 3. Describe friction bearing materials | <ul style="list-style-type: none"> <li>• Types</li> <li>• Applications</li> </ul>  |
| 4. Describe anti-friction bearings     | <ul style="list-style-type: none"> <li>• Construction               <ul style="list-style-type: none"> <li>○ Rolling elements                   <ul style="list-style-type: none"> <li>– Ball</li> <li>– Roller</li> <li>– Spherical</li> <li>– Cylindrical</li> <li>– Tapered roller</li> </ul> </li> </ul> </li> <li>• Bearing codes</li> </ul>  |
| 5. Describe types of seals             | <ul style="list-style-type: none"> <li>• Types</li> <li>• Applications</li> </ul>  |





**Line (GAC):**      **K    USE LATHES**  
**Competency:**    **K4    Cut Threads**

**Objectives**

To be competent in this area, the individual must be able to:

- Calculate metric threads.
- Cut and measure metric threads.

**LEARNING TASKS**

**CONTENT**

- |  |   |
|--|---|
| <p>1.    Cut metric threads</p>                | <ul style="list-style-type: none"> <li>• Plan sequence of operation               <ul style="list-style-type: none"> <li>○ Engagement points</li> <li>○ Speeds, feed and pitch</li> <li>○ Tool choice</li> <li>○ Tool alignment</li> </ul> </li> <li>• Set-up sequence               <ul style="list-style-type: none"> <li>○ Mounting workpiece</li> <li>○ Truing workpiece</li> <li>○ Balancing workpiece</li> <li>○ Centering workpiece</li> </ul> </li> <li>• Roughing               <ul style="list-style-type: none"> <li>○ Depth of cut</li> <li>○ Measuring</li> <li>○ Material allowance for finishing</li> </ul> </li> <li>• Finishing               <ul style="list-style-type: none"> <li>○ Depth of cut</li> <li>○ Deburring</li> <li>○ Measuring</li> </ul> </li> <li>• Measuring               <ul style="list-style-type: none"> <li>○ Gauge</li> <li>○ Micrometer</li> <li>○ Three-wire</li> </ul> </li> </ul> |
| <p>2.    Advanced thread cutting</p>           | <ul style="list-style-type: none"> <li>• Introduction to Acme</li> <li>• Stub Acme</li> <li>• Square thread</li> <li>• Modified square thread</li> <li>• Buttress</li> </ul>  |
| <p>3.    Gear ratio applications on lathes</p> | <ul style="list-style-type: none"> <li>• Change back gears for feeds and threads</li> <li>• Calculate gear ratios</li> </ul>  |



**Achievement Criteria**

- Performance The learner will be evaluated on the ability to:
- Calculate, measure and cut metric threads
- Conditions As part of practical lab tasks, given the required tools and materials.
- Criteria Tasks must be performed within specifications, safety standards and time frames acceptable to industry.





**Line (GAC):** L **USE MILLING MACHINES**  
**Competency:** L3 **Use Dividing Heads and Rotary Tables**

**Objectives**

To be competent in this area, the individual must be able to:

- Describe advanced dividing heads.
- Use advanced dividing heads.

**LEARNING TASKS**

**CONTENT**

- |  |   |
|--|---|
| <p>1. Describe advanced dividing heads</p> | <ul style="list-style-type: none"> <li>• Applications               <ul style="list-style-type: none"> <li>○ Milling                   <ul style="list-style-type: none"> <li>– Splines</li> <li>– Gears</li> <li>– Helical contours</li> </ul> </li> </ul> </li> </ul> |
| <p>2. Use advanced dividing heads</p>      | <ul style="list-style-type: none"> <li>• Mill               <ul style="list-style-type: none"> <li>○ Splines</li> <li>○ Gears</li> <li>○ Helical contours</li> </ul> </li> </ul>  |

**Achievement Criteria**

**Performance** The learner will be evaluated on the ability to:

- Use advanced dividing heads

**Conditions** As part of practical lab tasks, given the required tools and materials.

**Criteria** Tasks must be performed within specifications, safety standards and time frames acceptable to industry.



**Line (GAC):** L **USE MILLING MACHINES**  
**Competency:** L4 **Operate and Maintain Milling Machines**

**Objectives**

To be competent in this area, the individual must be able to:

- Operate and maintain milling machines.

**LEARNING TASKS**

1. Operate milling machines

**CONTENT**

- Plan sequence of operation
- Align machine
  - Spindle alignment
- Operations
  - Mill
    - Radii
    - Dovetails
    - Gears and racks
    - Helical contours
    - Gang milling

**Achievement Criteria**

**Performance** The learner will be evaluated on the ability to:

- Mill radii, dovetails, gears and racks, helical contours and gangs

**Conditions** As part of practical lab tasks, given the required tools and materials.

**Criteria** Tasks must be performed within specifications, safety standards and time frames acceptable to industry.



**Line (GAC):**        **M    USE SUPPORT MACHINES**  
**Competency:**     **M2    Operate and Maintain Hones and Lapping Machines**

**Objectives**

To be competent in this area, the individual must be able to:

- Describe hones and lapping machines.
- Operate and maintain hones and lapping machines.

**LEARNING TASKS**

**CONTENT**

- |  |  |
|--|--|
| <p>1.    Describe hones and lapping machines</p>   | <ul style="list-style-type: none"> <li>• Hones <ul style="list-style-type: none"> <li>○ Purpose</li> <li>○ Construction</li> <li>○ Applications</li> </ul> </li> <li>• Lapping machines <ul style="list-style-type: none"> <li>○ Purpose</li> <li>○ Construction</li> <li>○ Applications</li> </ul> </li> </ul>  |
| <p>2.    Operate and maintain hones</p>            | <ul style="list-style-type: none"> <li>• Safety precautions <ul style="list-style-type: none"> <li>○ Guards</li> <li>○ Personal protective equipment</li> <li>○ Housekeeping</li> </ul> </li> <li>• Positioning tool</li> <li>• Securing workpieces</li> <li>• Speeds and feeds</li> <li>• Cleaning</li> <li>• Lubrication</li> </ul>                          |
| <p>3.    Operate and maintain lapping machines</p> | <ul style="list-style-type: none"> <li>• Safety precautions <ul style="list-style-type: none"> <li>○ Guards</li> <li>○ Personal protective equipment</li> <li>○ Housekeeping</li> </ul> </li> <li>• Securing workpieces</li> <li>• Set speeds, feed rates and tool pressure</li> <li>• Lapping compounds</li> <li>• Cleaning</li> <li>• Lubrication</li> </ul> |



**Achievement Criteria**

Performance The learner will be evaluated on the ability to:

- Operate and maintain hones
- Operate and maintain lapping machines

Conditions As part of practical lab tasks, given the required tools and materials.

Criteria Tasks must be performed within specifications, safety standards and time frames acceptable to industry.



**Line (GAC): N USE GRINDERS AND ABRASIVES**

**Competency: N1 Describe Types of Grinders**

**Objectives**

To be competent in this area, the individual must be able to:

- Describe types of grinders and their applications.

**LEARNING TASKS**

1. Describe grinders

**CONTENT**

- Surface
  - Horizontal spindle
    - Purpose
    - Construction
    - Operation
  - Vertical spindle
    - Purpose
    - Construction
    - Operation
- Centreless
  - Purpose
  - Construction
  - Operation
- Cylindrical
  - Internal
    - Purpose
    - Construction
    - Operation
  - External
    - Purpose
    - Construction
    - Operation
- Tool and cutter
  - Purpose
  - Construction
  - Operation



**Line (GAC): N USE GRINDERS AND ABRASIVES**

**Competency: N2 Select Abrasives**

**Objectives**

To be competent in this area, the individual must be able to:

- Select abrasives for applications.

**LEARNING TASKS**

1. Select abrasives for applications

**CONTENT**

- Material type
  - Hardness
  - Toughness
  - Grindability
- Finish requirements
  - Coarse through fine grit
- Machine type
  - Area of contact
  - Depth of cut
  - Shape

**Achievement Criteria**

Performance The learner will be evaluated on the ability to:

- Select abrasives for different applications

Conditions As part of practical lab tasks, given the required tools and materials.

Criteria Tasks must be performed within specifications, safety standards and time frames acceptable to industry.



**Line (GAC): N USE GRINDERS AND ABRASIVES**

**Competency: N3 Operate and Maintain Grinders**

### Objectives

To be competent in this area, the individual must be able to:

- Operate and maintain cylindrical grinders.
- Operate and maintain centreless grinders.
- Operate and maintain tool and cutter grinders.
- Operate and maintain surface grinders.

### LEARNING TASKS

1. Operate and maintain cylindrical grinders

### CONTENT

- Calculate work speeds and feeds
- Material
  - Type
  - Size
- Wheel selection
- Wheel balancing
- Wheel truing and dressing
- Rigidity
- Support work
  - Chucks, faceplates, collets
  - Between centres
    - Drive dog
  - Steady rest/follower rest
- Set-up sequence
  - Mounting workpiece
  - Truing workpiece
- Maintenance
  - Cleaning
  - Lubricating
  - Housekeeping



2. Operate and maintain centreless grinders
  - Calculate control wheel speed and angle
  - Material
    - Type
    - Size
  - Wheel selection
  - Wheel balancing
  - Wheel truing and dressing
  - Rigidity
  - Set-up sequence
    - Mounting workpiece
  - Maintenance
    - Cleaning
    - Lubricating
    - Housekeeping
  
3. Operate and maintain tool and cutter grinders
  - Cutter type
  - Sharpening requirements
  - Wheel selection
  - Wheel truing and dressing
  - Set-up sequence
  - Grinding sequence
  - Maintenance
    - Cleaning
    - Lubricating
    - Housekeeping
  
4. Operate and maintain surface grinders
  - Calculate work speeds and feeds
  - Material
    - Type
    - Size
  - Wheel selection
  - Wheel truing and dressing
  - Rigidity
  - Workholding devices
  - Set-up sequence
  - Maintenance
    - Cleaning
    - Lubricating
    - Housekeeping





**Achievement Criteria**

Performance The learner will be evaluated on the ability to:

- Operate and maintain grinders

Conditions As part of practical lab tasks, given the required tools and materials.

Criteria Tasks must be performed within specifications, safety standards and time frames acceptable to industry.



**Line (GAC):**        **O    USE BORING MILLS**  
**Competency:**      **O1   Describe Boring Mills**

### Objectives

To be competent in this area, the individual must be able to:

- Describe vertical boring mills.
- Describe horizontal boring mills.
- Describe jig borers.

### LEARNING TASKS

1.    Describe vertical boring mills

### CONTENT

- Types
  - Mill
  - Turret lathe
- Components
  - Chuck
  - Ram slide
  - Bridge
  - Turret
  - Cross rail
- Accessories
  - Jaws
  - Clamps
- Operations
  - Boring
  - Turning
  - Taper
  - Facing
  - Drilling



2. Describe horizontal boring mills

- Types
  - Table
  - Saddle
  - Planer
  - Portable
- Components
  - Bed
  - Table
    - Fixed
    - Rotary
  - Columns
  - Tool heads
  - Facing slides
  - Spindles
- Accessories
  - Boring heads
  - Star wheel feed attachment
  - Measuring devices
  - Optics
  - Digital readouts
  - Rods
  - Line boring attachment
- Operations
  - Drilling
  - Boring
  - Line boring
  - Facing
  - Milling
  - Threading
- Layout of castings
- Layout of fabrication

3. Describe jig borers

- Applications



**Line (GAC):**        **O    USE BORING MILLS**  
**Competency:**      **O2   Operate and Maintain Vertical Boring Mills**

**Objectives**

To be competent in this area, the individual must be able to:

- Operate and maintain vertical boring mills.
- Set speeds and feeds.
- Install and remove tooling.

**LEARNING TASKS**

**CONTENT**

- |  |   |
|--|---|
| <ol style="list-style-type: none"> <li>1.    Set speeds and feeds</li> <br/> <li>2.    Support work</li> <br/> <li>3.    Install and remove tooling</li> <br/> <li>4.    Operate boring mills</li> </ol> | <ul style="list-style-type: none"> <li>• Calculations</li> <li>• Material <ul style="list-style-type: none"> <li>○ Type</li> <li>○ Size</li> </ul> </li> <li>• Tool type</li> <br/> <li>• Chucks</li> <li>• Clamps and hold-downs</li> <li>• Fixtures</li> <br/> <li>• Select tool for application</li> <li>• Maintain tool</li> <li>• Tool centering</li> <li>• Tool angle</li> <br/> <li>• Plan sequence of operation</li> <li>• Set-up sequence <ul style="list-style-type: none"> <li>○ Mounting workpiece</li> <li>○ Truing workpiece</li> <li>○ Balancing workpiece</li> <li>○ Centering workpiece</li> </ul> </li> <li>• Roughing <ul style="list-style-type: none"> <li>○ Speeds and feeds</li> <li>○ Cutters</li> <li>○ Depth of cut</li> <li>○ Measuring</li> <li>○ Material allowance for finishing</li> </ul> </li> </ul> |
|--|---|



- Finishing
    - Speeds and feeds
    - Cutters
    - Depth of cut
    - Deburring
    - Measuring
  - Operations
    - Turning
    - Drilling
    - Boring
    - Facing
    - Tapers
    - Parting
  
- 5. Maintain boring mills
  - Lubricate
  - Clean
  - Housekeeping

**Achievement Criteria**

- Performance The learner will be evaluated on the ability to:
- Operate and maintain vertical boring mills
  - Set speeds and feeds
  - Install and remove tooling
- Conditions As part of practical lab tasks, given the required tools and materials.
- Criteria Tasks must be performed within specifications, safety standards and time frames acceptable to industry.



# Level 4

# Machinist



**Line (GAC):** D USE MEASURING TOOLS  
**Competency:** D5 Describe Optical Measuring Equipment

### Objectives

To be competent in this area, the individual must be able to:

- Describe optical measuring equipment.

### LEARNING TASKS

1. Describe optical comparators

### CONTENT

- Types
  - Profiles
  - Reflection
- Components
  - Light source
  - Screen
  - Lenses
  - Table with micrometer adjustment
  - Centre
  - Vise
  - Angle plate
- Applications
  - Measuring
    - Thread forms
    - Profiles
    - Engraving
    - Angles
    - Radii



**Line (GAC):** E **INTERPRET DRAWINGS AND REFERENCE MATERIALS**  
**Competency:** E3 **Use Machinery's Handbook and other Reference Materials**

**Objectives**

To be competent in this area, the individual must be able to:

- Identify information found in the Machinery's Handbook.
- Locate information in the Machinery's Handbook.

**LEARNING TASKS**

**CONTENT**

- |   |   |
|---|---|
| <ol style="list-style-type: none"> <li>1. Locate information in the Machinery's Handbook</li> <br/> <li>2. Use other reference materials</li> </ol> | <ul style="list-style-type: none"> <li>• Formulas</li> <li>• Splines</li> <li>• Cams</li> <li>• Gears</li> <br/> <li>• Job plan               <ul style="list-style-type: none"> <li>○ machine limitations</li> </ul> </li> <li>• Quality Control Documentation               <ul style="list-style-type: none"> <li>○ Inspection sheets</li> <li>○ Blueprints</li> </ul> </li> </ul> |
|---|---|





**Line (GAC):** F **SELECT MATERIALS**  
**Competency:** F1 **Describe Principles of Metallurgy**

**Objectives**

To be competent in this area, the individual must be able to:

- Describe the raw resources used in the manufacture of iron and steel.
- Describe the manufacture of iron and steel.

**LEARNING TASKS**

**CONTENT**

- |  |   |
|--|---|
| <p>1. Review smelting processes</p>            | <ul style="list-style-type: none"> <li>• Coke</li> <li>• Iron ores</li> <li>• Limestone</li> <li>• Process</li> <li>• Blast furnace</li> </ul>  |
| <p>2. Review steel manufacturing processes</p> | <ul style="list-style-type: none"> <li>• Furnace types             <ul style="list-style-type: none"> <li>○ Basic oxygen                 <ul style="list-style-type: none"> <li>– Pig iron</li> <li>– Scrap steel</li> </ul> </li> <li>○ Open hearth                 <ul style="list-style-type: none"> <li>– Pig iron</li> <li>– Limestone</li> <li>– Natural gas</li> </ul> </li> <li>○ Electric                 <ul style="list-style-type: none"> <li>– Induction                     <ul style="list-style-type: none"> <li>* Scrap steel</li> </ul> </li> <li>– Arc                     <ul style="list-style-type: none"> <li>* Pig iron</li> <li>* Limestone</li> <li>* Scrap steel</li> </ul> </li> </ul> </li> </ul> </li> <li>• Carbon</li> <li>• Additional alloys</li> </ul> |



**Line (GAC):** F **SELECT MATERIALS**  
**Competency:** F2 **Describe Characteristics of Ferrous Metals**

**Objectives**

To be competent in this area, the individual must be able to:

- Describe SAE and AISI classifications.
- Identify steel characteristics by their designations.

**LEARNING TASKS**

**CONTENT**

- |  |  |
|--|--|
| <ol style="list-style-type: none"> <li>1. Review the Society of Automotive Engineers (SAE) and American Iron and Steel Institute (AISI) Classifications</li> <br/> <li>2. Review characteristics of steel for advanced applications by their designations</li> </ol> | <ul style="list-style-type: none"> <li>• Plain carbon steels</li> <li>• Standard alloy steels</li> <li>• Tool steels</li> <li>• Stainless steels</li> <li>• Numbering system</li> <br/> <li>• Carbon content</li> <li>• Alloying elements</li> <li>• Physical properties               <ul style="list-style-type: none"> <li>○ Wear resistance</li> <li>○ Weight</li> <li>○ Flexibility</li> <li>○ Hardness</li> <li>○ Toughness</li> <li>○ Corrosion resistance</li> <li>○ Ductility</li> <li>○ Machinability</li> <li>○ Conductivity                   <ul style="list-style-type: none"> <li>– Thermal</li> <li>– Electrical</li> </ul> </li> </ul> </li> <li>• Advanced applications</li> </ul> |
|--|--|



**Line (GAC):** F **SELECT MATERIALS**  
**Competency:** F3 **Describe Characteristics of Non-ferrous Metals**

**Objectives**

To be competent in this area, the individual must be able to:

- Describe the characteristics of non-ferrous metals.

**LEARNING TASKS**

**CONTENT**

- |  |  |
|--|--|
| <p>1. Review the UNS classifications of copper alloys</p>        | <ul style="list-style-type: none"> <li>• Alloys</li> <li>• Physical properties               <ul style="list-style-type: none"> <li>○ Wear resistance</li> <li>○ Weight</li> <li>○ Flexibility</li> <li>○ Hardness</li> <li>○ Toughness</li> <li>○ Corrosion resistance</li> <li>○ Ductility</li> <li>○ Machinability</li> <li>○ Conductivity                   <ul style="list-style-type: none"> <li>– Thermal</li> <li>– Electrical</li> </ul> </li> </ul> </li> <li>• Applications               <ul style="list-style-type: none"> <li>○ Electrical components</li> <li>○ Brass                   <ul style="list-style-type: none"> <li>– Ornamental castings</li> </ul> </li> <li>○ Bronze                   <ul style="list-style-type: none"> <li>– Bearings</li> </ul> </li> </ul> </li> </ul> |
| <p>2. Review the characteristics of other non-ferrous metals</p> | <ul style="list-style-type: none"> <li>• Material selection               <ul style="list-style-type: none"> <li>○ Babbitt</li> <li>○ Lead</li> <li>○ Nickel</li> <li>○ Tin</li> <li>○ Titanium</li> </ul> </li> <li>• Physical properties               <ul style="list-style-type: none"> <li>○ Wear resistance</li> <li>○ Weight</li> <li>○ Flexibility</li> <li>○ Hardness</li> <li>○ Toughness</li> </ul> </li> </ul>   |

**Program Content  
Level 4**



- Corrosion resistance
- Ductility
- Machinability
- Conductivity
  - Thermal
  - Electrical



**Line (GAC):** F **SELECT MATERIALS**  
**Competency:** F4 **Describe Characteristics of Non-metals**

### Objectives

To be competent in this area, the individual must be able to:

- Describe the characteristics of non-metals.

### LEARNING TASKS

1. Review plastics

### CONTENT

- Types
  - Thermoplastic
  - Thermoset
- Physical properties
  - Wear resistance
  - Weight
  - Flexibility
  - Hardness
  - Toughness
  - Ductility
  - Machinability
  - Conductivity
    - Thermal
    - Electrical
- Applications

2. Review rubbers

- Types
- Applications

3. Review lignum vitae

- Types
- Applications



**Line (GAC):** F **SELECT MATERIALS**  
**Competency:** F6 **Describe and Perform Heat Treating**

### Objectives

To be competent in this area, the individual must be able to:

- Describe heat treating processes.

### LEARNING TASKS

### CONTENT

- |                                   |   |
|-----------------------------------|---|
| 1. Review surface treatments      | <ul style="list-style-type: none"><li>• Plating<ul style="list-style-type: none"><li>○ Chrome</li><li>○ Gold</li><li>○ Nickel</li><li>○ Brass</li><li>○ Copper</li></ul></li><li>• Anodizing</li><li>• Bluing</li><li>• Spray welding</li></ul> |
| 2. Review heat treating processes | <ul style="list-style-type: none"><li>• Case hardening</li><li>• Through hardening</li><li>• Normalizing</li><li>• Annealing</li><li>• Flame hardening</li><li>• Induction hardening</li><li>• Tempering</li></ul>                              |
| 3. Review oxy-acetylene processes | <ul style="list-style-type: none"><li>• Safety</li><li>• System set-up</li><li>• Torch operation<ul style="list-style-type: none"><li>○ Heating</li><li>○ Heat treating</li></ul></li></ul>   |



**Line (GAC):** F **SELECT MATERIALS**  
**Competency:** F7 **Describe Materials Testing**

**Objectives**

To be competent in this area, the individual must be able to:

- Describe the physical properties and characteristics of steel.
- Perform hardness testing.

**LEARNING TASKS**

**CONTENT**

- |  |   |
|--|---|
| <ol style="list-style-type: none"> <li>1. Review the physical properties and characteristics of steel</li> <br/> <li>2. Review hardness tests</li> </ol> | <ul style="list-style-type: none"> <li>• Hardness</li> <li>• Tensile strength</li> <li>• Shear strength</li> <br/> <li>• Rockwell</li> <li>• Brinell</li> </ul> |
|--|---|



**Line (GAC):            G    PLAN SEQUENCE OF OPERATION**

**Competency:           G1   Determine Project Requirements**

**Objectives**

To be competent in this area, the individual must be able to:

- Determine project requirements from a complex drawing or sample.
- Plan C.N.C. manufacturing sequences.

**LEARNING TASKS**

**CONTENT**

- |   |  |
|---|--|
| <p>1.    Review the sequence of C.N.C. manufacturing operations</p> | <ul style="list-style-type: none"> <li>• Material requirements               <ul style="list-style-type: none"> <li>○ Types</li> <li>○ Machining allowances</li> </ul> </li> <li>• Machine tool               <ul style="list-style-type: none"> <li>○ Rough stock preparation</li> <li>○ Machining</li> </ul> </li> <li>• Select tooling</li> <li>• Inspection</li> </ul> |
| <p>2.    Plan manufacturing sequences</p>                           | <ul style="list-style-type: none"> <li>• C.N.C.               <ul style="list-style-type: none"> <li>○ Lathes</li> <li>○ Milling</li> </ul> </li> </ul>  |

**Achievement Criteria**

- Performance    The learner will be evaluated on the ability to:
- Plan C.N.C. manufacturing sequences
- Conditions      As part of practical lab tasks, given the required tools and materials.
- Criteria          Tasks must be performed within specifications, safety standards and time frames acceptable to industry.





**Line (GAC):**        **G    PLAN SEQUENCE OF OPERATION**  
**Competency:**      **G3   Perform Roughing and Finishing**

**Objectives**

To be competent in this area, the individual must be able to:

- Perform roughing and finishing processes using C.N.C. machines.

**LEARNING TASKS**

**CONTENT**

- |   |   |
|---|---|
| <p>1.    Perform roughing and finishing processes</p> | <ul style="list-style-type: none"> <li>• C.N.C.</li> <li>• Roughing <ul style="list-style-type: none"> <li>○ Speeds and feeds</li> <li>○ Cutters</li> <li>○ Measuring</li> <li>○ Material allowance for finishing</li> </ul> </li> <li>• Finishing <ul style="list-style-type: none"> <li>○ Speeds and feeds</li> <li>○ Cutters</li> <li>○ Measuring</li> </ul> </li> </ul> |
|---|---|

**Achievement Criteria**

**Performance**    The learner will be evaluated on the ability to:

- Perform roughing and finishing processes with a C.N.C. machine

**Conditions**     As part of practical lab tasks, given the required tools and materials.

**Criteria**         Tasks must be performed within specifications, safety standards and time frames acceptable to industry.



**Line (GAC): M USE SUPPORT MACHINES**

**Competency: M3 Operate and Maintain Gear Cutting and Electrical Discharge Machines**

**Objectives**

To be competent in this area, the individual must be able to:

- Describe gear cutting machines.
- Operate and maintain gear cutting machines.
- Describe electric discharge machines.
- Operate and maintain electric discharge machines.

**LEARNING TASKS**

**CONTENT**

1. Describe gear cutting machines	<ul style="list-style-type: none"> <li>• Purpose</li> <li>• Construction</li> <li>• Applications</li> </ul>
2. Operate and maintain gear cutting machines	<ul style="list-style-type: none"> <li>• Safety precautions               <ul style="list-style-type: none"> <li>○ Guards</li> <li>○ Personal protective equipment</li> <li>○ Housekeeping</li> </ul> </li> <li>• Positioning and securing workpiece</li> <li>• Coolant flow</li> <li>• Changing cutters</li> <li>• Cleaning</li> <li>• Lubrication</li> </ul>
3. Describe electrical discharge machines	<ul style="list-style-type: none"> <li>• Types</li> <li>• Purpose</li> <li>• Construction</li> <li>• Applications</li> </ul>
4. Operate and maintain electrical discharge machines	<ul style="list-style-type: none"> <li>• Safety precautions               <ul style="list-style-type: none"> <li>○ Guards</li> <li>○ Personal protective equipment</li> <li>○ Housekeeping</li> </ul> </li> <li>• Positioning and securing workpiece</li> <li>• Mounting and aligning electrode</li> <li>• Setting speeds and feeds</li> <li>• Cleaning</li> <li>• Lubrication</li> </ul>



**Achievement Criteria**

Performance	The learner will be evaluated on the ability to: <ul style="list-style-type: none"><li>• Operate and maintain gear cutting machines</li><li>• Operate and maintain electric discharge machines</li></ul>
Conditions	As part of practical lab tasks, given the required tools and materials.
Criteria	Tasks must be performed within specifications, safety standards and time frames acceptable to industry.



**Line O: USE BORING MILLS**  
**Competency: O1 Describe Boring Mills**

### Objectives

To be competent in this area, the individual must be able to:

- Describe vertical boring mills.
- Describe horizontal boring mills.
- Describe jig borers.

### LEARNING TASKS

1. Review vertical boring mills

### CONTENT

- Types
  - Mill
  - Turret lathe
- Components
  - Chuck
  - Ram slide
  - Bridge
  - Turret
  - Cross rail
- Accessories
  - Jaws
  - Clamps
- Operations
  - Boring
  - Turning
  - Taper
  - Facing
  - Drilling



2. Review horizontal boring mills

- Types
  - Table
  - Saddle
  - Planer
  - Portable
- Components
  - Bed
  - Table
    - Fixed
    - Rotary
  - Columns
  - Tool heads
  - Facing slides
  - Spindles
- Accessories
  - Boring heads
  - Star wheel feed attachment
  - Measuring devices
  - Optics
  - Digital readouts
  - Rods
  - Line boring attachment
- Operations
  - Drilling
  - Boring
  - Line boring
  - Facing
  - Milling
  - Threading
- Layout of castings
- Layout of fabrication

3. Review jig borers

- Applications



**Line (GAC):**        **O    USE BORING MILLS**  
**Competency:**      **O3    Operate and Maintain Horizontal Boring Mills**

**Objectives**

To be competent in this area, the individual must be able to:

- Operate and maintain horizontal boring mills.
- Set speeds and feeds.
- Install and remove tooling.

**LEARNING TASKS**

**CONTENT**

- |                                  |   |
|----------------------------------|---|
| 1.    Set speeds and feeds       | <ul style="list-style-type: none"> <li>• Calculations</li> <li>• Material <ul style="list-style-type: none"> <li>○ Type</li> <li>○ Size</li> </ul> </li> <li>• Tool type</li> </ul>   |
| 2.    Support work               | <ul style="list-style-type: none"> <li>• Clamp and hold-downs</li> <li>• Vises</li> <li>• Dividing heads</li> <li>• Rotating table</li> <li>• Fixtures <ul style="list-style-type: none"> <li>○ Sub-tables</li> </ul> </li> <li>• Angle plates</li> <li>• V-blocks</li> </ul> |
| 3.    Install and remove tooling | <ul style="list-style-type: none"> <li>• Select tool or cutter for application</li> <li>• Select boring bar and support bearing</li> <li>• Maintain tool</li> <li>• Tool centering</li> <li>• Tool angle</li> </ul>   |



## 4. Operate boring mills

- Plan sequence of operation
- Set-up sequence
  - Mounting workpiece
  - Align workpiece
  - Centering workpiece
  - Install boring bar
  - Install tooling
- Roughing
  - Speeds and feeds
  - Cutters
  - Depth of cut
  - Measuring
  - Material allowance for finishing
- Finishing
  - Speeds and feeds
  - Cutters
  - Depth of cut
  - Deburring
  - Measuring
- Operations
  - Drilling
  - Boring
  - Facing
  - Tapers
  - Threading
  - Milling
  - Outside diameter turning

## 5. Maintain boring mills

- Lubricate
- Clean
- Housekeeping



**Line (GAC):** P **USE C.N.C. MACHINES**  
**Competency:** P1 **Describe Computer Numerical Control (C.N.C.) Machines**

### Objectives

To be competent in this area, the individual must be able to:

- Describe C.N.C. machines.

### LEARNING TASKS

1. Describe C.N.C. machines

### CONTENT

- Types
  - Mills
  - Machining centres
  - Lathes
- Components
  - Controller
    - Manual data input
    - Offset page
    - Manual operation
    - Edit page
  - Tool carousel/changer
  - Table/Chuck
  - Spindle head
- Principles of operation
  - Computer control
  - Number of axes
  - Co-ordinate positioning
  - Programming codes
- Applications
  - Turning
  - Drilling
  - Boring
  - Facing
  - Tapers
  - Parting
  - Threading
    - Internal
    - External
  - Contours
  - Engraving



## Program Content Level 4



- Milling
  - Flat surfaces
  - Drill
  - Ream
  - Helical contours
- 3 dimensional surfaces



**Line (GAC):** P **USE C.N.C. MACHINES**  
**Competency:** P2 **Describe Co-ordinate Systems and Programming Codes**

**Objectives**

To be competent in this area, the individual must be able to:

- Describe co-ordinate systems and programming codes.
- Describe program writing procedures.

**LEARNING TASKS**

**CONTENT**

- |   |  |
|---|--|
| <p>1. Describe co-ordinate systems</p>        | <ul style="list-style-type: none"> <li>• Types               <ul style="list-style-type: none"> <li>○ Rectangular</li> <li>○ Polar</li> </ul> </li> <li>• Machine co-ordinates</li> <li>• Work co-ordinates</li> </ul>   |
| <p>2. Describe programming codes</p>          | <ul style="list-style-type: none"> <li>• Incremental</li> <li>• Absolute</li> <li>• Codes               <ul style="list-style-type: none"> <li>○ G</li> <li>○ M</li> <li>○ T</li> <li>○ F</li> <li>○ S</li> </ul> </li> <li>• Alarms</li> </ul>  |
| <p>3. Describe program writing procedures</p> | <ul style="list-style-type: none"> <li>• Control functions</li> <li>• Interaction of hardware and software</li> <li>• Programming instructions               <ul style="list-style-type: none"> <li>○ Sequence of commands</li> <li>○ Order of information found in a block</li> </ul> </li> </ul> |



**Line (GAC):** P **USE C.N.C. MACHINES**  
**Competency:** P3 **Operate and Maintain C.N.C. Machines**

**Objectives**

To be competent in this area, the individual must be able to:

- Program, operate and maintain C.N.C. lathes.
- Program, operate and maintain C.N.C. mills.

**LEARNING TASKS**

**CONTENT**

- |                          |   |
|--------------------------|---|
| 1. Set up C.N.C. machine | <ul style="list-style-type: none"> <li>• Start-up procedures</li> <li>• Plan sequence of operation               <ul style="list-style-type: none"> <li>○ Program the part</li> <li>○ Set-up workpiece</li> <li>○ Set-up tooling</li> <li>○ Verification</li> </ul> </li> <li>• Shut-down procedures</li> </ul> |
| 2. Program the part      | <ul style="list-style-type: none"> <li>• Ramping</li> <li>• Circular interpolation</li> <li>• Linear interpolation</li> <li>• Cutter compensation/tool offsets</li> <li>• Entry/exit points</li> <li>• Step-over/depth of cut</li> <li>• Set speeds and feeds</li> <li>• Write the program</li> </ul>           |
| 3. Set-up the workpiece  | <ul style="list-style-type: none"> <li>• Secure work               <ul style="list-style-type: none"> <li>○ Clamping pressure</li> </ul> </li> <li>• Hydraulic chucks</li> <li>• Offsets</li> <li>• Vices</li> </ul>  |
| 4. Set-up tooling        | <ul style="list-style-type: none"> <li>• Select tooling</li> <li>• Install tooling</li> <li>• Offsets</li> </ul>  |
| 5. Verify the program    | <ul style="list-style-type: none"> <li>• Simulation</li> <li>• Dry run</li> <li>• Graphics</li> </ul>   |



6. Operate C.N.C. machine
- Adjust offset parameters
    - Length
    - Diameter
    - Tool nose radius
  - Load / unload workpiece
  - Monitor machining processes
    - Machine alarms and codes
    - Signs of tool wear (vibration, noise)
    - Overrides (rapid, speed and feed)
    - Chip control problems
    - Cutting fluid delivery
  - Cycle interruption
    - Stop procedures
    - Corrective actions
    - Restarting

**Achievement Criteria**

- Performance** The learner will be evaluated on the ability to:
- Set up a C.N.C. machine and program the part
  - Set up the workplace and tooling
  - Verify the program and operate the C.N.C. machine
- Conditions** As part of practical lab tasks, given the required tools and materials.
- Criteria** Tasks must be performed within specifications, safety standards and time frames acceptable to industry.



# Section 4

## TRAINING PROVIDER STANDARDS



## Facility Requirements

### Classroom Area

- 900 sq. ft. for a class size of 12 - 16 students, with moveable tables and chairs
- Instructional media to include multimedia projector, projection screen, DVD player, and whiteboard

### Shop Area

- 175 sq. ft. per student
- Well heated and ventilated
- 22 ft. high ceilings
- Lighting appropriate to detailed work
- 200 sq. ft. clean-up / waste area

### Lab Requirements

- See Shop Area

### Student Facilities

- 20 sq. ft. per student for tools storage (indoors)
- Student locker and changeroom facilities

### Instructor's Office Space

- 150 sq. ft. per instructor, with a desk, chairs and materials storage / filing system

### Other

- 200 sq. ft. raw materials storage (may be outdoors)



## Tools and Equipment

### Shop Equipment

#### *Required*

- Abrasive cut-off saw
- Band saw (horizontal and vertical)
- Boring machines (horizontal and vertical)
- Computer numeric control (C.N.C.) simulator
- Drilling machines
- Electrical discharge machine (EDM)
- Grinders (cylindrical, surface, tool and cutter, pedestal, tool post profile)
- Hydraulic press
- Indexing heads
- Lathe (turret, engine, tracer, C.N.C.)
- Milling machines (vertical, horizontal, universal, Milling centres, C.N.C.)

#### *Recommended*

- Hobbing machine
- Key seater

### Shop (Facility) Tools

#### *Standard Tools*

- Abrasive cut off wheels
- Air grinder
- Air-driven hand tools
- Boring bars
- Boring heads
- Broaches
- Carbides (cemented, inserts, solid)
- Changeable pilot counterbores
- Circular saw
- Dies
- Disc grinder
- Drills (centre, spade, twist drill, oil hole, straight, fluid gun drills, hard steel drill, anular cutters, step drill, saw type hole cutter)
- Grinding wheels (aluminum oxide, silicon, carbide, boron carbide, cubicboron nitride, diamond, buffing wheels)
- Knurling tools (straight, tangential, diamond)
- Milling cutters (dovetail, gear, keyway, end mill T-slot, woodruff, side and face, slab, plain, chamfer, slitting saws, flycutters, formed, angle face, cemented carbide, carbide insert, solid carbide)
- Nibbler
- Reamers (machine, hand, spiral flute, straight, flute, expandable, rose, taper)
- Reciprocating saw
- Spotfacers
- Taps
- Line boring equipment
- Portable key seater
- Cold cut saw
- Disk grinder

**Hand Tools**

- Acetylene torch
- Allen keys
- Arbour press
- Bearing extractor
- Brushes
- Buffing wheels
- Chisels
- Chuck key
- Clamps
- Cloths
- Deburrers
- Die stock
- Drill drift
- Drill gauge
- Dressing stick
- Emery cloth
- File cards
- File handles
- Files
- Grease guns
- Hacksaws and blades
- Hand broaches
- Hand reamers
- Hammers/mallets
- Honing stones
- Lapping plate
- Oil cans/guns
- Pliers
- Scrapers (flat, bearing)
- Screwdrivers
- Socket wrenches
- Soft jaws
- Tap extractors
- Tap wrenches
- Torch tip lighters
- Vices
- Wheel dressers (hand held)
- Wrenches

**Measuring and Layout Tools**

- Angle plate
- Bore gauge
- Combination square
- Coordinate measuring machine (cmm)
- Depth gauge
- Dial indicators and magnetic base
- Digital readout
- Dividers
- Drill gauge
- Electronic measuring devices
- Etchers
- Feeler gauge
- Gauge blocks
- Gauge pins
- Gear measuring wire
- Go-no-go gauge (threads, diametrical)
- Height gauge
- Hermaphrodite callipers
- Inside callipers
- Layout fluid
- Measuring rods
- Measuring tape
- Optical comparator
- Outside callipers
- Plug/ring gauge
- Precision blocks
- Precision level
- Protractor (universal, bevel, vernier)
- Punches (centre, prick, transfer)
- Radius gauge
- Scale (steel, rule, hook rule)
- Scribes
- Sine bar (compound)
- Small hole gauge
- Snap gauge
- Square (solid, adjustable, cylindrical)
- Surface finish comparator
- Surface gauge
- Surface plate
- Telescopic gauge
- Three wire set
- Transfer calliper
- Vernier calliper (dial, digital)
- Vernier height gauge





**Set Up Accessories**

- Adaptors
- Angle plates
- Arbours
- Centre and edge finders
- Centres (dead, half, rotating, spring)
- Chucks (3-jaw, 4-jaw, 6-jaw, magnetic, tail stock)
- Colletts
- Crane
- Degreasing tanks
- Dividing head
- Drill chuck
- Face plates
- Follower/travelling rest
- Grinding attachment
- Hoists
- Lathe dogs
- Machine vice
- Mandrels
- Parallels
- Quick change toolpost
- Rotary table
- Shim stock
- Slings
- Spacers
- Steady rest
- Taper sleeve
- Taper turning attachment
- Tapping head
- Tool holders
- Turret toolpost
- Vee block
- Wheel balancers

**Safety Equipment**

- Eye wash station
- Face shield
- Required fire suppression equipment
- Required first aid coverage and equipment
- Safety barrier tapes

**Specialty Tools**

**Software**

- CAD/CAM software

**Student Equipment (supplied by school)**

**Required**

- Dust mask
- Hearing protectors

**Student Tools (supplied by student)**

**Required**

- Safety boots

**Recommended**

- Safety glasses
- Personal protective equipment (as determined by WorkSafeBC)
- Personal hearing protection



## Reference Materials

### Required Reference Materials

- Individualized Learning Machinist Modules from Alberta Learning.
  - BC Level 1 and 2 package
  - BC Level 3 and 4 package
- WorkSafe BC Regulations Online
- Technology of Machine Tools and Workbook
- Machinery's Handbook

### Recommended Resources

- NAIT Trade Mathematics for Machinists and Millwrights / Individualized Learning Millwright Modules from Alberta Learning
- Interpret Engineering Drawings (Canadian Edition)
- SKF Bearing Maintenance Handbook by the SKF Bearing Corporation
- Mathematics for Machine Technology, Smith
- Machinist Ready Reference

### Suggested Texts

- IPT Trade Handbooks Series
- Machine Tool Practices



## Instructor Requirements

### Occupation Qualification

The instructor must possess:

- Machinist Red Seal certification

### Work Experience

A minimum of 10 years' experience working in the industry as a journeyperson.

### Instructional Experience and Education

It is preferred that the instructor also possesses one of the following:

- Provincial (BC) Instructor Diploma or completion of a similar Trainer Training/Instructional Methods program, plus
- 2 years of supervisory or administrative experience
- Experienced user of CAD/CAM software



# Appendices



# Appendix A

## Assessment Guidelines



## Assessment Guidelines

Assessment Guidelines are the percentage weight of theory and practical assessment in technical training

### Apprenticeship Grading Sheets: Subject Competency and Weightings

PROGRAM: IN-SCHOOL TRAINING: ITA DIRECT ACCESS CODE:		MACHINIST LEVEL 1 0014MABL01	
LINE	SUBJECT COMPETENCIES	THEORY WEIGHTING	PRACTICAL WEIGHTING
A	Use Safe Work Practices	8.33%	9.09%
B	Use Hand Tools	8.33%	9.09%
C	Use Applied Mathematics	8.33%	9.09%
D	Use Measuring Tools	8.33%	9.09%
E	Interpret Drawings and Reference Materials	8.33%	9.09%
G	Plan Sequence of Operations	8.33%	9.09%
H	Describe Fabrication and Assembly	8.33%	0 %
I	Use Drilling Machines	8.33%	9.09%
J	Use Power Saws	8.33%	9.09%
K	Use Lathes	8.33%	9.09%
M	Use Support Machines	8.33%	9.09%
N	Use Grinders and Abrasives	8.33%	9.09%
	<b>Total</b>	<b>100%</b>	<b>100%</b>
<b>In-school theory / practical subject competency weighting</b>		80%	20%
<b>Final in-school percentage score</b>		IN-SCHOOL %	

<b>In-school Percentage Score</b> Combined theory and practical subject competency multiplied by	80%
<b>Standard Level Exam Percentage Score</b> The exam score is multiplied by	20%
<b>Final Percentage Score</b>	FINAL%



PROGRAM: IN-SCHOOL TRAINING: ITA DIRECT ACCESS CODE:		MACHINIST LEVEL 2 0014MABL02	
LINE	SUBJECT COMPETENCIES	THEORY WEIGHTING	PRACTICAL WEIGHTING
C	Use Applied Mathematics	12.50%	14.28%
D	Use Measuring Tools	12.50%	14.28%
E	Interpret Drawings and Reference Materials	12.50%	14.28%
F	Select Materials	12.50%	0%
G	Plan Sequence of Operation	12.50%	14.28%
K	Use Lathes	12.50%	14.28%
L	Use Milling Machines	12.50%	14.28%
N	Use Grinders and Abrasives	12.50%	14.28%
	<b>Total</b>	<b>100%</b>	<b>100%</b>
<b>In-school theory / practical subject competency weighting</b>		80%	20%
<b>Final in-school percentage score</b>		IN-SCHOOL %	

<b>In-school Percentage Score</b> Combined theory and practical subject competency multiplied by	80%
<b>Standard Level Exam Percentage Score</b> The exam score is multiplied by	20%
<b>Final Percentage Score</b>	FINAL%



PROGRAM: IN-SCHOOL TRAINING: ITA DIRECT ACCESS CODE:		MACHINIST LEVEL 3 0014MABL03	
LINE	SUBJECT COMPETENCIES	THEORY WEIGHTING	PRACTICAL WEIGHTING
C	Use Applied Mathematics	11.11%	9.09%
D	Use Measuring Tools	11.11%	9.09%
E	Interpret Drawings and Reference Materials	0%	9.09%
F	Select Materials	11.11%	9.09%
G	Plan Sequence of Operation	11.11%	9.09%
H	Describe Fabrication and Assembly	11.11%	9.09%
K	Use Lathes	11.11%	9.09%
L	Use Milling Machines	11.11%	9.09%
M	Use Support Machines	0%	9.09%
N	Use Grinders and Abrasives	11.11%	9.09%
O	Use Boring Mills	11.11%	9.09%
	<b>Total</b>	<b>100%</b>	<b>100%</b>
<b>In-school theory / practical subject competency weighting</b>		80%	20%
<b>Final in-school percentage score</b>		IN-SCHOOL %	

<b>In-school Percentage Score</b> Combined theory and practical subject competency multiplied by	80%
<b>Standard Level Exam Percentage Score</b> The exam score is multiplied by	20%
<b>Final Percentage Score</b>	FINAL%





PROGRAM: IN-SCHOOL TRAINING: ITA DIRECT ACCESS CODE:		MACHINIST LEVEL 4 / FINAL LEVEL 0014MA04	
LINE	SUBJECT COMPETENCIES	THEORY WEIGHTING	PRACTICAL WEIGHTING
D	Use Measuring Tools	15%	0%
E	Interpret Drawings and Reference Materials	0%	15%
F	Select Materials	15%	0%
G	Plan Sequence of Operation	15%	15%
M	Use Support Machines	0%	15%
O	Use Boring Mills	15%	15%
P	Use C.N.C. Machines	40%	40%
	<b>Total</b>	<b>100%</b>	<b>100%</b>
<b>In-school theory / practical subject competency weighting</b>		80%	20%

<p><b>Final in-school percentage score</b></p> <p>Apprentices must achieve a minimum 70% as the final in-school percentage score to be eligible to write the Interprovincial Red Seal or ITA CofQ exam.</p>	<p>IN-SCHOOL %</p>
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**All apprentices who complete Level 4 of the Machinist program with a FINAL level percentage score of 70% or greater will write the Interprovincial Red Seal examination as their final assessment.**

**ITA will enter the apprentices' Machinist Interprovincial Red Seal examination percentage score in ITA Direct Access.**

**A minimum percentage score of 70% on the examination is required for a pass.**



# Appendix B

## Glossary of Acronyms



ASME	American Society of Mechanical Engineers
AED	Automated external defibrillator
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineering
CAD	computer-aided design
CAM	computer- aided manufacturing
CBM	cubic boron nitride
CMM	coordinate measuring machine
C.N.C.	computer numerical control
EDM	electrical discharge machines
FPM	Feet per minute
HSS	high speed steel
IPM	Inches per minute
ISO	International Standards Organization
MTR	material test report
NPS	National Pipe Straight
NPT	National Pipe Taper
PLC	programmable logic controller
PPE	personal protective equipment
RPM	revolutions per minute
SAE	Society of Automotive Engineers
UN	Unified National
UNC	Unified National Course (a thread system for course threads)
UNF	Unified National Fine (a thread system for fine threads)
WHMIS	Workplace Hazardous Materials Information System



# Appendix C

## Previous Contributors



## Previous Contributors

The Program Outline was prepared with the advice and direction of an industry steering committee convened initially by the RTO (Resource Training Organization). Members include:

- Steve Anderson                      Department of National Defense
- Danny Bradford                      BC Federation of Labour
- Larry Dosalph                        Teck
- Ralph Finch                            Thompson Rivers University
- Dana Goedbloed                      Kwantlen Polytechnic University
- Wayne Muzylowski                    West Fraser (Eurocan Pulp and Paper)
- James Piwek                            Teck
- Brad Smith                             Catalyst Paper
- Cindy Soderstom                      CAODC (Rig Tech Trade)
- Gene Von Matt                        Elk Valley Coal
- Wayne Wetmore                      Enform Training
- Trevor Williams                      BC Institute of Technology

**Subject Matter Experts retained to assist in the development of Program Outline (2008) content:**

- Dave Baker                            Kodak Graphic Communication
- James Cai                              BC Institute of Technology
- Tim Duthie                             Elk Valley Coal Corp
- Paul Ghotra                            CIMtech Mfg Inc
- Richard Turnbull                      Department of National Defense
- Alastair Haythornthwaite            International Association of Machinists DL 250
- Uwe zum Hingst                      Zum Hingst Technologies Inc.
- John MacKinnon                      Avcorp Industries Inc.
- Gary Markham                        Raute Wood Ltd.
- Dave Sanford                         Howe Sound Pulp and Paper
- Tim Walls                              Pazmac Enterprises
- Guy Walton                            Kodak Graphic Communication
- Reinhard Wildauer                    College of New Caledonia