TRAINING REGULATIONS

CNC MILLING MACHINE OPERATION NC III

METALS AND ENGINEERING SECTOR

TECHNICAL EDUCATION AND SKILLS DEVELOPMENT AUTHORITY
East Service Road, South Superhighway, Taguig City, Metro Manila

TABLE OF CONTENTS

METALS AND ENGINEERING SECTOR

CNC MILLING MACHINE OPERATION NC III

TRAINING REGULATIONS FOR

CNC MILLING MACHINE OPERATION NC III

SECTION 1 CNC MILLING MACHINE OPERATION NC III QUALIFICATION

The CNC Milling Machine Operation NC III Qualification consists of competencies that a person must achieve to write advanced CNC milling machine program, set-up multiple-axis CNC milling machine, workpiece and cutting tools and perform advanced CNC milling machine operations.

The Units of Competency comprising this qualification include the following:

Code No.	BASIC COMPETENCIES
500311109	Lead workplace communication
500311110	Lead small teams
500311111	Develop and practice negotiation skills
500311112	Solve problems related to work activities
500311113	Use mathematical concepts and techniques
500311114	Use relevant technologies

Code No.	COMMON COMPETENCIES
MEE722201	Apply safety practices
MEE722202	Interpret working drawings and sketches
MEE722203	Select/ cut workshop materials
MEE722204	Perform shop computations (Basic)
MEE722205	Measure workpiece (Basic)
MEE722206	Perform routine housekeeping
MEE722207	Perform shop computations (Intermediate)
MEE722208	Measure workpiece using angular measuring instruments
MEE 722209	Perform shop computations (Advanced)
MEE722210	Measure workpiece using gages and surface texture comparator
MEE722211	Perform preventive and corrective maintenance
MEE311212	Prepare cost estimates

Code No.	CORE COMPETENCIES
MEE821310	Write advanced CNC milling machine program
MEE821311	Set-up multiple-axis CNC milling machine, workpiece and cutting tools
MEE821312	Perform advanced CNC milling machine operations

A person who has achieved this qualification is competent to be:
- CNC Milling Machine Operator (Advanced)

SECTION 2 COMPETENCY STANDARDS

This section gives the details of the contents of the core units of competency required in CNC MILLING MACHINE OPERATION NC III.

BASIC COMPETENCIES

UNIT OF COMPETENCY : LEAD WORKPLACE COMMUNICATION

UNIT CODE : 500311109

UNIT DESCRIPTOR : This unit covers the knowledge, skills and attitudes required to lead in the dissemination and discussion of ideas, information and issues in the workplace.

ELEMENT	PERFORMANCE CRITERIA ***Italicized terms*** are elaborated in the Range of Variables
1. Communicate information about workplace processes	1.1. Appropriate ***communication method*** is selected 1.2. Multiple operations involving several topics areas are communicated accordingly 1.3. Questions are used to gain extra information 1.4. Correct sources of information are identified 1.5. Information is selected and organized correctly 1.6. Verbal and written reporting is undertaken when required 1.7. Communication skills are maintained in all situations
2. Lead workplace discussions	2.1. Response to workplace issues are sought 2.2. Response to workplace issues are provided immediately 2.3. Constructive contributions are made to workplace discussions on such issues as production, quality and safety 2.4. Goals/objectives and action plan undertaken in the workplace are communicated
3. Identify and communicate issues arising in the workplace	3.1. Issues and problems are identified as they arise 3.2. Information regarding problems and issues are organized coherently to ensure clear and effective communication 3.3. Dialogue is initiated with appropriate personnel 3.4. Communication problems and issues are raised as they arise

RANGE OF VARIABLES

VARIABLE	RANGE
1. Methods of communication	1.1. Non-verbal gestures 1.2. Verbal 1.3. Face to face 1.4. Two-way radio 1.5. Speaking to groups 1.6. Using telephone 1.7. Written 1.8. Internet

EVIDENCE GUIDE

1. Critical aspects of Competency	Assessment requires evidence that the candidate*:* 1.1. Dealt with a range of communication/information at one time 1.2. Made constructive contributions in workplace issues 1.3. Sought workplace issues effectively 1.4. Responded to workplace issues promptly 1.5. Presented information clearly and effectively written form 1.6. Used appropriate sources of information 1.7. Asked appropriate questions 1.8. Provided accurate information
2. Underpinning knowledge	2.1. Organization requirements for written and electronic communication methods 2.2. Effective verbal communication methods
3. Underpinning Skills	3.1. Organize information 3.2. Understand and convey intended meaning 3.3. Participate in variety of workplace discussions 3.4. Comply with organization requirements for the use of written and electronic communication methods
4. Resource Implications	The following resources **MUST** be provided: 4.1. Variety of Information 4.2. Communication tools 4.3. Simulated workplace
5. Method of Assessment	Competency may be assessed through: 5.1. Direct Observation 5.2. Interview
6. Context for Assessment	Competency may be assessed in the workplace or in simulated workplace environment

UNIT OF COMPETENCY : LEAD SMALL TEAMS

UNIT CODE : 500311110

UNIT DESCRIPTOR : This unit covers the knowledge, skills and attitudes to lead small teams including setting and maintaining team and individual performance standards.

ELEMENT	PERFORMANCE CRITERIA ***Italicized terms*** are elaborated in the Range of Variables
1. Provide team leadership	1.1. ***Work requirements*** are identified and presented to team members 1.2. Reasons for instructions and requirements are communicated to team members 1.3. ***Team members' queries and concerns*** are recognized, discussed and dealt with
2. Assign responsibilities	2.1. Duties, and responsibilities are allocated having regard to the skills, knowledge and aptitude required to properly undertake the assigned task and according to company policy 2.2. Duties are allocated having regard to individual preference, domestic and personal considerations, whenever possible
3. Set performance expectations for team members	3.1. Performance expectations are established based on client needs and according to assignment requirements 3.2. Performance expectations are based on individual team members duties and area of responsibility 3.3. Performance expectations are discussed and disseminated to individual team members
4. Supervised team performance	4.1. ***Monitoring of performance*** takes place against defined performance criteria and/or assignment instructions and corrective action taken if required 4.2. Team members are provided with *feedback*, positive support and advice on strategies to overcome any deficiencies 4.3. ***Performance issues*** which cannot be rectified or addressed within the team are referenced to appropriate personnel according to employer policy 4.4. Team members are kept informed of any changes in the priority allocated to assignments or tasks which might impact on client/customer needs and satisfaction 4.5. Team operations are monitored to ensure that employer/client needs and requirements are met 4.6. Follow-up communication is provided on all issues affecting the team 4.7. All relevant documentation is completed in accordance with company procedures

RANGE OF VARIABLES

VARIABLE	RANGE
1. Work requirements	1.1. Client Profile 1.2. Assignment instructions
2. Team member's concerns	2.1. Roster/shift details
3. Monitor performance	3.1. Formal process 3.2. Informal process
4. Feedback	4.1. Formal process 4.2. Informal process
5. Performance issues	5.1. Work output 5.2. Work quality 5.3. Team participation 5.4. Compliance with workplace protocols 5.5. Safety 5.6. Customer service

EVIDENCE GUIDE

1. Critical aspects of Competency	Assessment requires evidence that the candidate: 1.1. Maintained or improved individuals and/or team performance given a variety of possible scenario 1.2. Assessed and monitored team and individual performance against set criteria 1.3. Represented concerns of a team and individual to next level of management or appropriate specialist and to negotiate on their behalf 1.4. Allocated duties and responsibilities, having regard to individual's knowledge, skills and aptitude and the needs of the tasks to be performed 1.5. Set and communicated performance expectations for a range of tasks and duties within the team and provided feedback to team members
2. Underpinning Knowledge	2.1. Company policies and procedures 2.2. Relevant legal requirements 2.3. How performance expectations are set 2.4. Methods of Monitoring Performance 2.5. Client expectations 2.6. Team member's duties and responsibilities
3. Underpinning Skills	3.1. Communication skills required for leading teams 3.2. Informal performance counseling skills 3.3. Team building skills 3.4. Negotiating skills
4. Resource Implications	The following resources **MUST** be provided: 4.1. Access to relevant workplace or appropriately simulated environment where assessment can take place 4.2. Materials relevant to the proposed activity or task
5. Method of Assessment	Competency may be assessed through: 5.1. Direct observations of work activities of the individual member in relation to the work activities of the group 5.2. Observation of simulation and/or role play involving the participation of individual member to the attainment of organizational goal 5.3. Case studies and scenarios as a basis for discussion of issues and strategies in teamwork
6. Context for Assessment	6.1. Competency assessment may occur in workplace or any appropriately simulated environment 6.2. Assessment shall be observed while task are being undertaken whether individually or in-group

UNIT OF COMPETENCY: DEVELOP AND PRACTICE NEGOTIATION SKILLS

UNIT CODE : 500311111

UNIT DESCRIPTOR : This unit covers the skills, knowledge and attitudes required to collect information in order to negotiate to a desired outcome and participate in the negotiation.

ELEMENT	PERFORMANCE CRITERIA ***Italicized terms*** are elaborated in the Range of Variables
1. Plan negotiations	1.1 Information on ***preparing for negotiation*** is identified and included in the plan 1.2 Information on creating ***non verbal environments*** for positive negotiating is identified and included in the plan 1.3 Information on ***active listening*** is identified and included in the plan 1.4 Information on different ***questioning techniques*** is identified and included in the plan 1.5 Information is checked to ensure it is correct and up-to- date
2. Participate in negotiations	2.1 Criteria for successful outcome are agreed upon by all parties 2.2 Desired outcome of all parties are considered 2.3 Appropriate language is used throughout the negotiation 2.4 A variety of questioning techniques are used 2.5 The issues and processes are documented and agreed upon by all parties 2.6 Possible solutions are discussed and their viability assessed 2.7 Areas for agreement are confirmed and recorded 2.8 Follow-up action is agreed upon by all parties

RANGE OF VARIABLES

VARIABLE	RANGE
1. Preparing for negotiation	1.1 Background information on other parties to the negotiation 1.2 Good understanding of topic to be negotiated 1.3 Clear understanding of desired outcome/s 1.4 Personal attributes 1.4.1 self awareness 1.4.2 self esteem 1.4.3 objectivity 1.4.4 empathy 1.4.5 respect for others 1.5 Interpersonal skills 1.5.1 listening/reflecting 1.5.2 non verbal communication 1.5.3 assertiveness 1.5.4 behavior labeling 1.5.5 testing understanding 1.5.6 seeking information 1.5.7 self disclosing 1.6 Analytic skills 1.6.1 observing differences between content and process 1.6.2 identifying bargaining information 1.6.3 applying strategies to manage process 1.6.4 applying steps in negotiating process 1.6.5 strategies to manage conflict 1.6.6 steps in negotiating process 1.6.7 options within organization and externally for resolving conflict
2. Non verbal environments	2.1 Friendly reception 2.2 Warm and welcoming room 2.3 Refreshments offered 2.4 Lead in conversation before negotiation begins
3. Active listening	3.1 Attentive 3.2 Don't interrupt 3.3 Good posture 3.4 Maintain eye contact 3.5 Reflective listening
4. Questioning techniques	4.1 Direct 4.2 Indirect 4.3 Open-ended

EVIDENCE GUIDE

1. Critical aspects of Competency	Assessment requires evidence that the candidate: 1.1 Demonstrated sufficient knowledge of the factors influencing negotiation to achieve agreed outcome 1.2 Participated in negotiation with at least one person to achieve an agreed outcome
2. Underpinning Knowledge and Attitude	2.1 Codes of practice and guidelines for the organization 2.2 Organizations policy and procedures for negotiations 2.3 Decision making and conflict resolution strategies procedures 2.4 Problem solving strategies on how to deal with unexpected questions and attitudes during negotiation 2.5 Flexibility 2.6 Empathy
3. Underpinning Skills	3.1 Interpersonal skills to develop rapport with other parties 3.2 Communication skills (verbal and listening) 3.3 Observation skills 3.1 Negotiation skills
4. Resource Implications	The following resources **MUST** be provided: 4.1 Room with facilities necessary for the negotiation process 4.2 Human resources (negotiators)
5. Methods of Assessment	Competency may be assessed through: 5.1 Observation/demonstration and questioning 5.2 Portfolio assessment 5.3 Oral and written questioning 5.4 Third party report
6. Context for Assessment	Competency to be assessed in real work environment or in a simulated workplace setting.

UNIT OF COMPETENCY : SOLVE PROBLEMS RELATED TO WORK ACTIVITIES

UNIT CODE : 500311112

UNIT DESCRIPTOR : This unit of covers the knowledge, skills and attitudes required to solve problems in the workplace including the application of problem solving techniques and to determine and resolve the root cause of problems.

ELEMENT	PERFORMANCE CRITERIA ***Italicized terms*** are elaborated in the Range of Variables
1. Identify the problem	1.1. Variances are identified from normal operating parameters; and product quality 1.2. Extent, cause and nature are of the problem are defined through observation, investigation and ***analytical techniques*** 1.3. ***Problems*** are clearly stated and specified
2. Determine fundamental causes of the problem	2.1. Possible causes are identified based on experience and the use of problem solving tools / analytical techniques. 2.2. Possible cause statements are developed based on findings 2.3. Fundamental causes are identified per results of investigation conducted
3. Determine corrective action	3.1. All possible options are considered for resolution of the problem 3.2. Strengths and weaknesses of possible options are considered 3.3. Corrective actions are determined to resolve the problem and possible future causes 3.4. **Action *plans*** are developed identifying measurable objectives, resource needs and timelines in accordance with safety and operating procedures
4. Provide recommendation/s to manager	4.1. Report on recommendations are prepared 4.2. Recommendations are presented to appropriate personnel. 4.3. Recommendations are followed-up, if required

RANGE OF VARIABLES

VARIABLE	RANGE
1. Analytical techniques	1.1. Brainstorming 1.2. Intuitions/Logic 1.3. Cause and effect diagrams 1.4. Pareto analysis 1.5. SWOT analysis 1.6. Gant chart, Pert CPM and graphs 1.7. Scattergrams
2. Problem	2.1. Non – routine process and quality problems 2.2. Equipment selection, availability and failure 2.3. Teamwork and work allocation problem 2.4. Safety and emergency situations and incidents
3. Action plans	3.1. Priority requirements 3.2. Measurable objectives 3.3. Resource requirements 3.4. Timelines 3.5. Co-ordination and feedback requirements 3.6. Safety requirements 3.7. Risk assessment 3.8. Environmental requirements

EVIDENCE GUIDE

1. Critical aspects of Competency	Assessment requires evidence that the candidate: 1.1. Identified the problem 1.2. Determined the fundamental causes of the problem 1.3. Determined the correct / preventive action 1.4. Provided recommendation to manager These aspects may be best assessed using a range of scenarios / case studies / what ifs as a stimulus with a walk through forming part of the response. These assessment activities should include a range of problems, including new, unusual and improbable situations that may have happened.
2. Underpinning Knowledge	2.1. Competence includes a thorough knowledge and understanding of the process, normal operating parameters, and product quality to recognize non-standard situations 2.2. Competence to include the ability to apply and explain, sufficient for the identification of fundamental cause, determining the corrective action and provision of recommendations 2.2.1. Relevant equipment and operational processes 2.2.2. Enterprise goals, targets and measures 2.2.3. Enterprise quality, OHS and environmental requirement 2.2.4. Principles of decision making strategies and techniques 2.2.5. Enterprise information systems and data collation 2.2.6. Industry codes and standards
3. Underpinning Skills	3.1. Using range of formal problem solving techniques 3.2. Identifying and clarifying the nature of the problem 3.3. Devising the best solution 3.4. Evaluating the solution 3.5. Implementation of a developed plan to rectify the problem

4. Resource Implications	Assessment will require access to an operating plant over an extended period of time, or a suitable method of gathering evidence of operating ability over a range of situations. A bank of scenarios / case studies / what ifs will be required as well as bank of questions which will be used to probe the reason behind the observable action.
5. Method of Assessment	Competency may be assessed through: 5.1. Case studies on solving problems in the workplace 5.2. Observation The unit will be assessed in a holistic manner as is practical and may be integrated with the assessment of other relevant units of competency. Assessment will occur over a range of situations, which will include disruptions to normal, smooth operation. Simulation may be required to allow for timely assessment of parts of this unit of competency. Simulation should be based on the actual workplace and will include walk through of the relevant competency components.
6. Context for Assessment	In all workplace, it may be appropriate to assess this unit concurrently with relevant teamwork or operation units.

UNIT OF COMPETENCY: **USE MATHEMATICAL CONCEPTS AND TECHNIQUES**

UNIT CODE : **500311113**

UNIT DESCRIPTOR : This unit covers the knowledge, skills and attitudes required in the application of mathematical concepts and techniques.

ELEMENT	Performance Criteria ***Italicized terms*** are elaborated in the Range of Variables
1. Identify mathematical tools and techniques to solve problem	1.1 Problem areas are identified based on given condition 1.2 ***Mathematical techniques*** are selected based on the given problem
2. Apply mathematical procedure/solution	2.1 Mathematical techniques are applied based on the problem identified 2.2 Mathematical computations are performed to the level of accuracy required for the problem 2.3 Results of mathematical computation is determined and verified based on job requirements
3. Analyze results	3.1 Result of application is reviewed based on expected and required specifications and outcome 3.2 ***Appropriate action*** is applied in case of error

RANGE OF VARIABLES

VARIABLE	RANGE
1. Mathematical techniques	May include but are not limited to: 1.1 Four fundamental operations 1.2 Measurements 1.3 Use/Conversion of units of measurements 1.4 Use of standard formulas
2. Appropriate action	2.1 Review in the use of mathematical techniques (e.g. recalculation, re-modeling) 2.2 Report error to immediate superior for proper action

EVIDENCE GUIDE

1. Critical Aspects of Competency	Assessment requires evidence that the candidate identified, applied and reviewed the use of mathematical concepts and techniques to workplace problems
2. Underpinning Knowledge	2.1 Fundamental operation (addition, subtraction, division, multiplication) 2.2 Measurement system 2.3 Precision and accuracy 2.4 Basic measuring tools/devices
3. Underpinning Skills	3.1 Applying mathematical computations 3.2 Using calculator 3.3 Using different measuring tools
4. Resource Implications	The following resources **MUST** be provided: 4.1 Calculator 4.2 Basic measuring tools 4.3 Case Problems
5. Method of Assessment	Competency may be assessed through: 5.1 Authenticated portfolio 5.2 Written Test 5.3 Interview/Oral Questioning 5.4 Demonstration
6. Context for Assessment	Competency may be assessed in the work place or in a simulated work place setting

UNIT OF COMPETENCY: USE RELEVANT TECHNOLOGIES

UNIT CODE : 500311114

UNIT DESCRIPTOR : This unit of competency covers the knowledge, skills, and attitude required in selecting, sourcing and applying appropriate and affordable technologies in the workplace.

ELEMENT	PERFORMANCE CRITERIA ***Italicized terms*** are elaborated in the Range of Variables
1. Study/select appropriate technology	1.1 Usage of different ***technologies*** is determined based on job requirements 1.2 Appropriate technology is selected as per work specification
2. Apply relevant technology	2.1 Relevant technology is effectively used in carrying out function 2.2 Applicable software and hardware are used as per task requirement 2.3 ***Management concepts*** are observed and practiced as per established industry practices
3. Maintain/enhance ~~of~~ relevant technology	3.1 Maintenance of technology is applied in accordance with the ***industry standard operating procedure***, ***manufacturer's operating guidelines*** and ***occupational health and safety procedure*** to ensure its operative ability 3.2 Updating of technology is maintained through continuing education or training in accordance with job requirement 3.3 Technology failure/ defect is immediately reported to the concern/responsible person or section for ***appropriate action***

RANGE OF VARIABLES

VARIABLE	RANGE
1. Technology	May include but are not limited to: 1.1 Office technology 1.2 Industrial technology 1.3 System technology 1.4 Information technology 1.5 Training technology
2. Management concepts	May include but not limited to: 2.1 Real Time Management 2.2 KAIZEN or continuous improvement 2.3 5s 2.4 Total Quality Management 2.5 Other management/productivity tools
3. Industry standard operating procedure	3.1 Written guidelines relative to the usage of office technology/equipment 3.2 Verbal advise/instruction from the co-worker
4. Manufacturer's operating guidelines/ instructions	4.1 Written instruction/manuals of specific technology/ equipment 4.2 General instruction manual 4.3 Verbal advise from manufacturer relative to the operation of equipment
5. Occupational health and safety procedure	5.1 Relevant statutes on OHS 5.2 Company guidelines in using technology/equipment
6. Appropriate action	6.1 Implementing preventive maintenance schedule 6.2 Coordinating with manufacturer's technician

EVIDENCE GUIDE

1. Critical aspects of Competency	Assessment requires evidence that the candidate: 1.1 Studied and selected appropriate technology consistent with work requirements 1.2 Applied relevant technology 1.3 Maintained and enhanced operative ability of relevant technology
2. Underpinning Knowledge	2.1 Awareness on technology and its function 2.2 Repair and maintenance procedure 2.3 Operating instructions 2.4 Applicable software 2.5 Communication techniques 2.6 Health and safety procedure 2.7 Company policy in relation to relevant technology 2.8 Different management concepts 2.9 Technology adaptability
3. Underpinning Skills	3.1 Relevant technology application/implementation 3.2 Basic communication skills 3.3 Software applications skills 3.4 Basic troubleshooting skills
4. Resource Implications	The following resources **MUST** be provided: 4.1 Relevant technology 4.2 Interview and demonstration questionnaires 4.3 Assessment packages
5. Method of Assessment	Competency may be assessed through: 5.1 Interview 5.2 Actual demonstration 5.3 Authenticated portfolio (related certificates of training/seminar)
6. Context for Assessment	Competency may be assessed in actual workplace or simulated environment

COMMON COMPETENCIES

UNIT OF COMPETENCY: APPLY SAFETY PRACTICES

UNIT CODE: MEE722201

UNIT DESCRIPTOR: This unit covers the competencies required to apply safety practices in the workplace.

ELEMENTS	PERFORMANCE CRITERIA ***Italicized terms*** are elaborated in the Range of Variables
1. Identify hazards	1.1 ***Hazards*** are identified correctly in accordance with OHS principles. 1.2 Safety signs and symbols are identified and adhered to.
2. Use protective clothing and devices	2.1 Appropriate ***protective clothing and devices*** correctly selected and used in accordance with OHS requirements or industry/company policy
3. Perform safe handling of tools, equipment and materials	3.1 Safety procedures for pre-use check and operation of tools and equipment followed in accordance with industry/ company policies. 3.2 Tools, equipment and materials handled safely in accordance with OHS requirements and industry/ company policies.
4. Perform first aid	4.1 First aid treatment of ***injuries*** are carried out according to recommended procedures
5. Use fire extinguisher	5.1 Fire extinguisher selected and operated correctly according to the ***type of fire***.

RANGE OF VARIABLES

VARIABLE	RANGE
1. Hazards	1.1 Cluttered tools and materials 1.2 Slippery floors (caused by oil, grease or any liquid) 1.3 Exposed electrical wires 1.4 Sharp edges 1.5 Machine without guards or with exposed moving parts 1.6 Uncollected chips or other wastes etc.
2. Protective clothing and devices	Protective clothing and devices may include but is not limited to: 2.1 safety glasses/goggles 2.2 safety shoes 2.3 overalls 2.4 cap
3. Injuries	Injuries may include: 3.1 burns/scalds 3.2 fractures 3.3 cuts and abrasions 3.4 poisoning 3.5 foreign bodies in the eye 3.6 concussion 3.7 shock
4. Type of fires	Fires involving or caused by: 4.1 common combustibles (wood, cloth, paper, rubber and plastic) 4.2 flammable liquids (gasoline, oil, solvents, paints, etc.) 4.3 energized electrical equipment (wiring, fuse boxes, circuit breakers, appliances, etc. 4.4 combustible metals (magnesium, sodium, etc.)

EVIDENCE GUIDE

1. Critical aspects of Competency	Assessment requires evidence that the candidate: 1.1 identified hazardous area 1.2 used protective clothing and devices 1.3 handled tools, equipment and materials properly 1.4 performed first aid 1.5 used fire extinguisher
2. Underpinning knowledge and attitude	2.1 Shop safety signs, symbols and alarms 2.2 Safety precautionary measures 2.3 Housekeeping 2.4 Machine tools 2.5 First aid 2.6 Engineering materials 2.7 Fire extinguishers
3. Underpinning skills	3.1 Operating machine tools 3.2 Handling tools and materials 3.3 Communicating with superiors and co-workers 3.4 Interpreting instructions
4. Resource implications	The following resources **MUST** be provided 4.1 Tools, equipment and facilities appropriate to processes or activity 4.2 Materials relevant to the proposed activity
5. Method of assessment	Competency may be assessed through: 5.1 Demonstration 5.2 Written or oral short answer questions 5.3 Practical exercises
6. Context for assessment	Competency may be assessed in the workplace or in simulated workplace environment.

UNIT OF COMPETENCY: **INTERPRET WORKING DRAWINGS AND SKETCHES**

UNIT CODE: **MEE722202**

UNIT DESCRIPTOR: This unit covers the competencies required to read and interpret drawings and sketches.

ELEMENTS	PERFORMANCE CRITERIA ***Italicized terms*** are elaborated in the Range of Variables
1. Interpret technical drawing	1.1 Components, assemblies or objects recognized as required. 1.2 Dimensions identified as appropriate. 1.3 Instructions identified and followed as required. 1.4 Material requirements identified as required. 1.5 Symbols recognized as appropriate in the ***drawing*.** 1.6 ***Tolerance***, limits and fits identified in the drawing.
2. Prepare freehand sketch of parts	2.1 Sketch drawn correctly and appropriately. 2.2 Sketch depicted objects or part appropriately. 2.3 Dimensions indicated in sketch are clear and correct. 2.4 Instructions included in sketch are clear and correct. 2.5 Base line or datum points indicated as required.
3. Interpret details from freehand sketch	3.1 Components, assemblies or objects recognized as required. 3.2 Dimensions identified as appropriate. 3.3 Instructions identified and followed as required. 3.4 Material requirements identified as required. 3.5 Symbols recognized as appropriate in the drawing.

RANGE OF VARIABLES

VARIABLE	RANGE
1. Drawing	1.1 Drawing technique include 1.1.1 Perspective 1.1.2 Exploded view 1.1.3 Hidden view technique 1.2 Projections 1.2.1 First angle projections 1.2.2 Third angle projections
2. Tolerance	2.1 General tolerance 2.2 Angular tolerance 2.3 Geometric tolerance

EVIDENCE GUIDE

1. Critical aspects of Competency	Assessment requires evidence that the candidate: 1.1 Interpreted technical drawing 1.2 Prepared sketches 1.3 Interpreted sketches.
2. Underpinning knowledge	2.1 Alphabet of lines 2.2 Projections 2.3 Drawing symbols 2.4 Dimensioning techniques 2.5 Tolerance, limits and fits 2.6 Engineering materials 2.7 Drawing tools and supplies
3. Underpinning skills	3.1 Handling tools and drawing instruments 3.2 Using measuring instruments
4. Resource implications	The following resources **MUST** be provided: 4.1 Drafting room/facilities and drafting instruments and supplies appropriate to the activity 4.2 Measuring tools 4.3 Drawings, sketches or blueprint 4.4 Specimen parts/components
5. Method of assessment	Competency may be assessed through: 5.1 direct observation 5.2 written or oral short answer questions 5.3 demonstration 5.4 project/work sample 5.5 portfolio
6. Context for assessment	Competency may be assessed in the workplace or in simulated workplace environment.

UNIT OF COMPETENCY: **SELECT/ CUT WORKSHOP MATERIALS**

UNIT CODE: **MEE722203**

UNIT DESCRIPTOR: This unit covers the skills and knowledge required to select and cut workshop materials

ELEMENTS	PERFORMANCE CRITERIA ***Italicized terms*** are elaborated in the Range of Variables
1. Determine requirement	1.1 ***Plans/ drawings*** are interpreted to produce component to specification 1.2 Sequence of operation is determined to produce component to specification
2. Select and measure materials	2.1 ***Materials*** are selected according to the requirement of the operation 2.2 Materials are measured to required level of accuracy using measuring tools 2.3 Measuring tools are used according to manufacturers specification
3. Cut materials	3.1 Materials are cut according to plans/drawing instruction 3.2 ***Cutting tools/equipment*** are used based on manufacturers specification, appropriate techniques or the *safety procedure*

RANGE OF VARIABLES

VARIABLE	RANGE
1. Plan/drawings	1.1 Dimensions 1.2 Tolerance
2. Materials	2.1 Ferrous 2.2 Non-ferrous
3. Measuring tools	3.1 Steel rule 3.2 Pull-push rule
4. Cutting tools/equipment	4.1 Hacksaw 4.2 Power hacksaw
5. Safety procedure	Safety involves the handling of: 5.1 Equipment 5.2 Tools 5.3 Materials

EVIDENCE GUIDE

1. Critical Aspects of Competency	Assessment requires evidence that the candidate: 1.1 Interpreted plans/drawings 1.2 Selected natural according to the requirement 1.3 Performed cutting operation 1.4 Cutting tools/equipment used safely
2. Underpinning knowledge and attitude	2.1 Shop safety practices 2.1.1 Safe working habits 2.1.2 Safe handling of tools, equipment and materials 2.2 Blueprint reading 2.2.1 Standard drawing scales, symbols and abbreviations 2.2.2 Assembly and details of drawing 2.2.3 Dimensions 2.3 Measurement 2.3.1 Linear measuring tools 2.4 Materials and related science 2.4.1 Classification and mechanical properties of engineering materials
3. Underpinning skills	3.1 Selecting materials 3.2 Using measuring tools 3.3 Operating power hacksaw
4. Resource implications	The following resources **MUST** be provided: 4.1 Tools, equipment and facilities appropriate processes of an activity 4.2 Materials relevant to the proposal activity 4.3 Drawings/plans
5. Method Assessment	Competency may be assessed through: 5.1 Direct observation 5.2 Oral short answer question 5.3 Practical exercises
6. Context for assessment	Competency may be assessed in the workplace or in simulated work environment

UNIT OF COMPETENCY: **PERFORM SHOP COMPUTATIONS (BASIC)**

UNIT CODE: **MEE722204**

UNIT DESCRIPTOR: This unit covers the competencies required to perform basic calculations using the four fundamental operation.

ELEMENTS	PERFORMANCE CRITERIA ***Italicized terms*** are elaborated in the Range of Variables
1. Perform four fundamental operations.	1.1 Simple calculations performed using *four **fundamental operations.*** 1.2 Simple calculations performed involving fractions and mixed numbers using four fundamental operations
2. Perform basic calculations involving fractions and decimals	2.1 Simple calculations are performed involving fractions and decimals using the four fundamental operations. 2.2 Decimal are converted into fraction (and vice versa) accurately,
3. Perform basic calculations involving percentages.	3.1 Simple calculations are performed to obtain percentages from information expressed in either fractional or decimal format
4. Perform basic calculation involving ration and proportion	4.1 Simple calculations are performed involving ratios and proportion using whole numbers, fractions and decimal fractions.
5. Perform calculations on algebraic expressions	5.1 Simple calculations are performed on ***algebraic expressions*** using the four fundamental operations. 5.2 Simple transposition of formulae is carried out to isolate the variable required, involving the four fundamental operations.

RANGE OF VARIABLES

VARIABLE	RANGE
1. Four fundamental operations	1.1 Addition 1.2 Subtraction 1.3 Multiplication 1.4 Division
2. Algebraic expressions	Calculation using formula for determining: 2.1 tap drill size 2.2 feed 2.3 speed

EVIDENCE GUIDE

1. Critical aspects of Competency	Assessment requires evidence that the candidate performed calculations: 1.1 using four fundamental operations 1.2 involving fractions and mixed numbers 1.3 involving fractions and decimals 1.4 involving percentages 1.5 involving ratio and proportion 1.6 on algebraic expressions 1.7 of simple formulae
2. Underpinning knowledge and attitude	English and metric system of measurements
3. Underpinning skills	Performing calculations using pen and paper or on a calculator
4. Resource implications	The following resources **MUST** be provided: 4.1 Tools, equipment and facilities appropriate to processes or activity 4.2 Materials relevant to the proposed activity
5. Method of assessment	Competency may be assessed through: 5.1 written or oral short answer questions 5.2 practical exercises
6. Context for assessment	Competency may be assessed in the workplace or in simulated workplace environment.

UNIT OF COMPETENCY: **MEASURE WORKPIECE (BASIC)**

UNIT CODE: **MEE722205**

UNIT DESCRIPTOR: This unit covers the competencies required to measure workpieces using measuring instruments such as steel rules, vernier calipers , micrometers, etc….

ELEMENTS	PERFORMANCE CRITERIA ***Italicized terms*** are elaborated in the Range of Variables
1. Select and use measuring tools	1.1 ***Measuring tools*** are selected and used according to the level of accuracy required. 1.2 ***Measurements*** taken are accurate to the finest graduation of the selected measuring instrument. 1.3 Measuring technique used is correct and appropriate to the device used.
2. Clean and store measuring tools	2.1 Care and storage of devices undertaken to manufacturer's specifications or standard operating procedures.

RANGE OF VARIABLES

VARIABLE	RANGE
1. Measuring tools	Measuring tools include 1.1 Steel tape 1.2 Steel rule 1.3 Straight edge 1.4 Combination square 1.5 Steel square 1.6 Divider or trammel 1.7 Caliper 1.8 Protractor 1.9 Vernier caliper 1.10 Micrometer
2. Measurements	2.1 length 2.2 diameter 2.3 depth 2.4 flatness 2.5 straightness 2.6 squareness

EVIDENCE GUIDE

1. Critical aspects of competency	Assessment requires evidence that the candidate: 1.1 Selected and used measuring instruments 1.2 Cleaned and stored measuring instruments
2. Underpinning knowledge	2.1 Types, purposes and accuracy of measuring instruments 2.2 Capability of measuring instruments 2.3 Part dimensions and tolerances 2.4 Techniques for measuring dimensions 2.5 Care and storage procedure of measuring tools
3. Underpinning skills	3.1 Safe handling of measuring tools and materials
4. Resource implications	The following resources **MUST** be provided: 4.1 Tools, equipment and facilities appropriate to the activity 4.2 Specimen component or part to the proposed activity
5. Method of assessment	Competency may be assessed through: 5.1 direct observation 5.2 demonstration 5.3 written or oral short answer questions 5.4 portfolio
6. Context for assessment	Competency may be assessed in the workplace or in simulated workplace environment.

UNIT OF COMPETENCY: **PERFORM ROUTINE HOUSEKEEPING**

UNIT CODE: **MEE722206**

UNIT DESCRIPTOR: This unit covers the competencies required to maintain an organized and clean work area.

ELEMENTS	PERFORMANCE CRITERIA ***Italicized terms*** are elaborated in the Range of Variables
1. Organize work area	1.1 Work area maintained in a safe, uncluttered and organized manner according to ***workshop policy***. 1.2 All tasks carried out safely, effectively and efficiently with minimum inconvenience according to workshop policy. 1.3 Workshop policies and procedures for tidying work areas and placing items in designated areas applied.
2. Clean work area	2.1 Shop policies and procedures applied for cleaning ***work area.*** 2.2 Wastes promptly removed and disposed of according to shop policies and environmental requirements. 2.3 Spills, wastes and other potential hazards reported to appropriate personnel and removed according to shop policies and environmental requirements. Signage promptly displayed in regard to unsafe areas. 2.4 Consumable materials maintained and stored correctly after use. 2.5 ***Tools and equipment*** (including guards) cleaned and used in accordance with manufacturer's instructions. 2.6

RANGE OF VARIABLES

VARIABLE	RANGE
1. Workshop policy	Shop policy and procedure in regard to: 1.1 Housekeeping practices 1.2 Maintenance and storage of cleaning equipment 1.3 Use and storage of cleaning chemicals
2. Work area	Work area may include: 2.1 Work benches 2.2 Walkways and aisles 2.3 Fixtures and other working surfaces
3. Tools and Equipment	Equipment and tools may include: 3.1 Drill Press 3.2 Pedestal Grinder 3.3 Surface plate 3.4 Layout and marking tools 3.5 Cutting tools (hacksaw, chisel, files) 3.6 Inspection and measuring tools (templates, vernier caliper, micrometer, straight edge, gages, etc…)

EVIDENCE GUIDE

1. Critical aspects of competency	Assessment requires evidence that the candidate organized and cleaned work area according shop policies and environmental requirements.
2. Underpinning knowledge and attitude	2.1 Shop safety practices 2.2 Machine shop equipment 2.3 Shop policies regulations 2.4 5-S 2.5 Shop cleaning equipment
3. Underpinning skills	3.1 Using and storing of cleaning equipment 3.2 Using and storing chemicals, hazardous substances and flammable liquids 3.3 Literacy and numeracy skills in reading and understanding labels and instructions for the handling and use of chemicals and hazardous substances 3.4 Communication skills 3.5 Organizing skills
4. Resource implications	The following resources **MUST** be provided: 4.1 Tools, equipment and facilities appropriate to processes or activity 4.2 Materials and documentation relevant to the proposed activity 4.3 Shop policy and/or procedures manual on housekeeping, cleaning and occupational health and safety
5. Method of assessment	Competency may be assessed through: 5.1 direct observation 5.2 demonstration or role play 5.3 written or oral short answer questions 5.4 identify colleagues/clients who can be approached for the collection of competency evidence, where appropriate
6. Context for assessment	Competency may be assessed in the workplace or in simulated workplace environment.

UNIT OF COMPETENCY: **PERFORM SHOP COMPUTATIONS (INTERMEDIATE)**

UNIT CODE: **MEE722207**

UNIT DESCRIPTOR: This unit covers the competencies required to perform calculation involving triangles and tapers.

ELEMENTS	PERFORMANCE CRITERIA ***Italicized terms*** are elaborated in the Range of Variables
1. Perform calculations involving triangles	1.1 Problems involving right triangles are performed using the ***trigonometric functions***. 1.2 Problems involving non-right triangles are performed using sine and cosine rules.
2. Calculate taper	2.1 Taper of work calculated correctly using appropriate formula.

RANGE OF VARIABLES

VARIABLE	RANGE
1. trigonometric functions	1.1 Sine 1.2 Cosine 1.3 Tangent 1.4 Cotangent 1.5 Secant 1.6 Cosecant

EVIDENCE GUIDE

1. Critical aspects of competency	Assessment requires evidence that the candidate performed calculations: 1.1 Involving right triangles 1.2 Involving non-right triangles 1.3 involving tapers
2. Underpinning knowledge and attitude	2.1 English and metric system of measurements 2.2 Geometrical shapes
3. Underpinning skills	3.1 Performing calculations using pen and paper or on a calculator
4. Resource implications	The following resources **MUST** be provided: 4.1 Tools, equipment and facilities appropriate to processes or activity 4.2 Materials relevant to the proposed activity
5. Method of assessment	Competency may be assessed through: 5.1 written or oral short answer questions 5.2 practical exercises
6. Context for assessment	Competency may be assessed in the workplace or in simulated workplace environment.

UNIT OF COMPETENCY: **MEASURE WORKPIECE USING ANGULAR MEASURING INSTRUMENTS**

UNIT CODE: **MEE722208**

UNIT DESCRIPTOR: This unit covers the competencies required to measure workpieces using angular measuring instruments.

ELEMENTS	PERFORMANCE CRITERIA ***Italicized terms*** are elaborated in the Range of Variables
1. Select and use angular measuring tools	1.1 ***Angular measuring tools*** are selected and used according to the level of accuracy required. 1.2 ***Measurements*** taken are accurate to the finest graduation of the selected measuring instrument. 1.3 Measuring technique used is correct and appropriate to the device used.
2. Maintain angular measuring tools	2.1 Measuring tools are adjusted and maintained to the required accuracy utilizing manufacturer's or worksite procedures.
3. Clean and store measuring tools	3.1 Care and storage of devices undertaken to manufacturer's specifications or standard operating procedures.

RANGE OF VARIABLES

VARIABLE	RANGE
1. Angular measuring tools	Measuring tools include 1.1 Bevel protractor 1.2 Gage blocks 1.3 Sine bar
2. Measurements	2.1 angle 2.2 taper

EVIDENCE GUIDE

1. Critical aspects of competency	Assessment requires evidence that the candidate: 1.1 Selected and used angular measuring instruments 1.2 Maintained/adjusted instruments 1.3 Cleaned and stored measuring instruments
2. Underpinning knowledge	2.1 Types, purposes and accuracy of angular measuring instruments 2.2 Capability of measuring tools 2.3 Techniques for measuring angles and tapers 2.4 Care and storage procedure of measuring tools
3. Underpinning skills	3.1 Safe handling of measuring tools and materials 3.2 Reading vernier scale 3.3 Reading micrometer
4. Resource implications	The following resources **MUST** be provided: 4.1 Tools, equipment and facilities appropriate to the activity 4.2 Specimen component or part to the proposed activity
5. Method of assessment	Competency may be assessed through: 5.1 direct observation 5.2 demonstration 5.3 written or oral short answer questions 5.4 portfolio
6. Context for assessment	Competency may be assessed in the workplace or in simulated workplace environment.

UNIT OF COMPETENCY: **PERFORM SHOP COMPUTATIONS (ADVANCED)**

UNIT CODE: **MEE722209**

UNIT DESCRIPTOR: This unit covers the competencies required to perform calculation involving gear ratio, indexing problems and gearing problems.

ELEMENTS	PERFORMANCE CRITERIA ***Italicized terms*** are elaborated in the Range of Variables
1. Calculate gear ratio	1.1 ***Gear ratio*** calculated using appropriate formula
2. Solve indexing problems	2.1 ***Indexing*** problems involving number of turns, spaces and circle plate are solved using appropriate formula
3. Solve gearing problems	3.1 Gearing problems are solved using appropriate formula
4. Use geometrical principles in the solution of problems	4.1 Solution to problems is obtained by applying geometrical properties of angles, triangles and circles in the calculation.

RANGE OF VARIABLES

VARIABLE	RANGE
1. gear ratio	1.1 addendum 1.2 clearance 1.3 dedendum 1.4 diametral pitch 1.5 module 1.6 outside diameter 1.7 pitch diameter 1.8 root diameter 1.9 number of teeth etc.
2. indexing	2.1 direct indexing 2.2 simple indexing 2.3 compound indexing 2.4 differential indexing

EVIDENCE GUIDE

1. Critical aspects of competency	Assessment requires evidence that the candidate performed calculations: 1.1 involving gear ratio 1.2 involving indexing problems 1.3 involving gearing problems 1.4 involving geometrical properties of angles, triangles and circles
2. Underpinning knowledge and attitude	2.1 English and metric system of measurements 2.2 Geometrical shapes 2.3 Gear types
3. Underpinning skills	3.1 Performing calculations using pen and paper or on a calculator 3.2 Reading and interpreting working drawings
4. Resource implications	The following resources **MUST** be provided: 4.1 Tools, equipment and facilities appropriate to processes or activity 4.2 Materials relevant to the proposed activity
5. Method of assessment	Competency may be assessed through: 5.1 written or oral short answer questions 5.2 practical exercises
6. Context for assessment	Competency may be assessed in the workplace or in simulated workplace environment.

UNIT OF COMPETENCY: **MEASURE WORKPIECE USING GAGES AND SURFACE TEXTURE COMPARATOR**

UNIT CODE: **MEE722210**

UNIT DESCRIPTOR: This unit covers the competencies required to measure workpieces using fixed and adjustable gages.

ELEMENTS	PERFORMANCE CRITERIA ***Italicized terms*** are elaborated in the Range of Variables
1. Select and use fixed and adjustable gages	1.1 Appropriate ***gages*** are selected and used to undertake the required comparison or measurement using standard operating procedures. 1.2 Consistent and accurate ***measurements*** obtained conforms to drawing specification 1.3 Measuring technique used is correct and appropriate to the device used.
2. Perform surface texture measurements	2.1 Surface textures are measured according worksite procedures. 2.2 Measurements taken are within the level of accuracy required.
3. Clean and store measuring tools	3.1 Care and storage of devices undertaken to manufacturer's specifications or standard operating procedures.

RANGE OF VARIABLES

VARIABLE	RANGE
1. Gages	Fixed and adjustable gages include: 1.1 Gage blocks 1.2 Telescoping gages 1.3 Center gages 1.4 Thread gages 1.5 Dial bore gages 1.6 Height gages 1.7 Radius gages 1.8 Go-no-go gages 1.9 Depth gages
2. Measurements	Measurements undertaken may include: 2.1 Linear dimensions 2.2 Diameters 2.3 Depths 2.4 Fits 2.5 Tapers 2.6 Threads 2.7 Radius 2.8 Squareness 2.9 Surface texture etc

EVIDENCE GUIDE

1.	Critical aspects of competency	Assessment requires evidence that the candidate: 1.1 Selected and used fixed and adjustable gages 1.2 Performed surface texture measurements 1.3 Cleaned and stored measuring instruments
2.	Underpinning knowledge	2.1 Types and application of fixed and adjustable gages 2.2 Gage limits and accuracy 2.3 Techniques for measuring components 2.4 Care and storage procedure of measuring tools
3.	Underpinning skills	3.1 Safe handling of measuring tools and materials 3.2 Verifying measurements with drawing specifications
4.	Resource implications	The following resources **MUST** be provided: 4.1 Tools, equipment and facilities appropriate to the activity 4.2 Specimen component or part to the proposed activity 4.3 Drawing
5.	Method of assessment	Competency may be assessed through: 5.1 direct observation 5.2 demonstration 5.3 written or oral short answer questions 5.4 portfolio
6.	Context for assessment	Competency may be assessed in the workplace or in simulated workplace environment.

UNIT OF COMPETENCY **PERFORM PREVENTIVE AND CORRECTIVE MAINTENANCE**

UNIT CODE: **MEE722211**

UNIT DESCRIPTOR: This unit covers the knowledge and skills required in performing preventive and corrective maintenance such as inspection and repair of hand tools, cleaning and lubrication of machine parts and changing drive pulley and belts.

ELEMENTS	PERFORMANCE CRITERIA ***Italicized terms*** are elaborated in the Range of Variables
1. Perform inspection of machine	1.1 ***Machine*** inspected ***according to worksite procedures.*** 1.2 Status/Report recorded on proforma or reported orally according to worksite procedure.
2. Perform cleaning and lubricating of machine	2.1 ***Machines*** lubricated as per manufacturer's recommendation using appropriate ***tools and materials*** 2.2 Fluids and lubricants replaced and/or topped up according to prescribed schedule.
3. Perform minor machine repair and adjustments	3.1 Minor machine repairs performed according to manufacturer's instruction or worksite procedures. 3.2 Machine moving parts adjusted to manufacturer's specifications.
4. Maintain hand tools	4.1 Tool cutting ground to recommended specifications 4.2 Hand tools lubricated and stored according to prescribed procedure

RANGE OF VARIABLES

VARIABLES	RANGE
1. Inspected	Inspected machine parts include: 1.1 V-belt 1.2 Bearing 1.3 Gears 1.4 Clutch 1.5 Drive pulley
2. Machines	Machine include but not limited to: 2.1 Lathe machine 2.2 Milling machine 2.3 Grinding machine
2. Tools and materials	Tools and materials used include: 3.1 Lubricants 3.2 Oil can 3.3 Grease gun 3.4 Oil 3.5 Coolant or compound

EVIDENCE GUIDE

1. Critical aspects of competency	Assessment requires evidence that that the candidate: 1.1 Performed inspection of machine 1.2 Performed cleaning and lubricating of machine 1.3 Performed minor machine repairs and adjustments
2. Underpinning knowledge	2.1 Proper cleaning and oiling 2.2 Kinds of oil 2.3 Parts and function of machine tools 2.4 Cutting oil, coolant or compound 2.5 Pulleys and belts 2.6 Location of main switches of the machine 2.7 Handling and storage of tools 2.8 Checklist of safe working conditions 2.9 Procedures in cleaning and disposal of waste materials
3. Underpinning skills	3.1 Inspecting and repairing hand tools 3.2 Inspecting and changing drive pulleys and belts 3.3 Replacing and adjusting machine parts 3.4 Distinguishing old and new coolant 3.5 Distinguishing odor of polluted coolant 3.6 Selecting coolant, cutting oil or compounds 3.7 Changing coolant 3.8 Inspecting work area for safe working environment 3.9 Cleaning work area 3.10 Disposing metal scraps, chips and waste materials.
4. Resource Implications	The following resources **MUST** be provided: 4.1 Tools, equipment and facilities appropriate to processes or activity 4.2 Materials relevant to the proposed activity
5. Method of Assessment	Competency **may** be assessed through: 5.1 direct observation of activities 5.2 oral or written questioning
6. Context for Assessment	Competency may be assessed in the workplace or in simulated workplace environment.

UNIT OF COMPETENCY: PREPARE COST ESTIMATES

UNIT CODE :

UNIT DESCRIPTOR : This unit covers the outcomes required to calculate costs for a particular job order/request in a machine-shop or metal-working environment.

ELEMENT	PERFORMANCE CRITERIA ***Italicized*** terms are elaborated in the Range of Variables
1. Determine customer requirements	1.1. Plans/ drawings are interpreted to produce component to specifications. 1.2. Cost-effective sequence of operations to produce component to specifications is determined in accordance with ***worksite policies.*** 1.3. Where available, sample part or product is inspected for parameters relevant to cost determination. 1.4. Materials are determined according to the job requirements. 1.5. Additional details of job are obtained through discussion with customer or from information supplied. 1.6. Where applicable, client is advised on the feasibility and cost-effectiveness of the production job based on the constraints/capabilities of the machine and current market prices.
2. Estimate cost components	2.1 ***Cost components*** are calculated based on job requirements and ***worksite procedures***. 2.2 Where necessary data on current costs are verified with the current market price. 2.3 Appropriate personnel are consulted with regard to additional data for costing.
3. Cost the job	3.1. Costing is set at optimal and affordable levels based on customer requirements and worksite procedures. 3.2. Where necessary, initial/rough cost estimate is provided to client following worksite procedures. 3.3. ***Total production costs*** are determined and finalized in accordance with worksite procedures***.***
4. Verify and document costs	4.1. Cost quotations are finalized and cleared with personnel concerned. 4.2. Costing details are documented and filed for future re-use or reference based on worksite procedures.

RANGE OF VARIABLES

VARIABLE	RANGE
1. Cost components	May include : 1.1 Labor cost 1.2 Hourly machine cost 1.3 Overhead / energy cost 1.4 Capital 1.5 Depreciation costs 1.6 Prototyping costs 1.7 Storage/carrying costs 1.8 Contingency costs 1.9 Mark-up 1.10 Freight/shipping charges 1.11 Taxes
2. Total production cost	May include 2.1 Supplies and materials Raw materials 2.1.1 Ferrous materials 2.1.2 Non – ferrous materials 2.1.3 Non-metallic materials 2.1.4 Tooling requirements High speed tools Carbide inserts Ceramics Diamond cutters 2.2 Labor cost 2.3 Equipment rentals and depreciation
3. Worksite policies and procedures	May include 3.1 Mark-up procedures 3.2 Machine-shop production schedules 3.3 Cost-quotation approval procedures 3.4 Cost-accounting policies 3.5 Cost-center policies 3.6 Quality and documentation procedures 3.7 Tooling/Re-tooling procedures 3.8 Optimization of production/operations

EVIDENCE GUIDE

1. Critical aspects of evidence	Assessment requires evidence that the candidate 1.1 Determined job requirements 1.2 Determined material requirements 1.3 Estimated and documented costs
2. Underpinning knowledge and attitude	2.1 Blueprint reading 2.2.1 Standard drawing scales, symbols and abbreviations 2.2.2 Assembly and details of drawing 2.2.3 Dimensions 2. 2 Materials and related science 2.2.1 Classification and mechanical properties of engineering materials 2.3 Quality procedures 2.4 Quality control and assurance principles 2.5 Cost-estimation procedures 2.6 Production optimization 2.7 Work values: cost-consciousness, quality-consciousness, client/service focus
3. Underpinning skills	3.1 Determining optimum sequence of operations 3.2 Selecting materials 3.3 Operating power hacksaw 3.4 Writing CNC programs 3.5 Operating CNC machines 3.6 Operating grinding machine (optional)
4. Resource implications	The following resources should be provided 4.1 Tools, equipment and facilities appropriate to the job/activity 4.2 Materials relevant to the proposal activity 4.3 Drawings/plans or sample parts
5. Method Assessment	The following assessment activity are suggested 5.1 Direct observation with oral questioning 5.2 Written questioning 5.3 Demonstration with oral questioning
6. Context for assessment	Competency may be assessed in the workplace or in simulated work environment.

CORE COMPETENCIES

UNIT OF COMPETENCY : **Write Advanced CNC Milling Machine Program**

UNIT CODE : **MEE821310**

UNIT DESCRIPTOR : This unit covers the skills required to write complex programs for CNC milling machine with 3 or more axes.

ELEMENTS	PERFORMANCE CRITERIA ***Italicized*** terms are elaborated in the Range of Variables
1. Determine job requirements	1.1 ***Drawings*** are interpreted to produce component to specifications. 1.2 Sequence of operation is determined to produce component according to specification. 1.3 ***Cutting tools*** are selected according to the requirements of the operation. 1.4 Cutting speed and feed rate calculated based on ***workpiece*** and cutting tool material. 1.5 Process / job / adjustment sheets are filled up with relevant machine, tool and raw material data.
2 Write advanced CNC milling machine program	2.1 Coordinates calculated for complex tool path or advanced machining functions based on part or product to be produced. 2.2 Program written in standard CNC ***milling operations***, code format in accordance with standard operating procedures.
3 Edit advanced CNC milling machine programs	3.1 Program is simulated and edited according to standard operating procedures. 3.2 Program is saved to the machine according to standard operating procedures. 3.3 Program is downloaded to the machine according to standard operating procedures.(Optional)

RANGE OF VARIABLES

VARIABLE	RANGE
1. Drawings	Reading and interpretation: 1.1 Dimensions and symbols 1.2 Tolerances
2. Cutting Tools	Cutting tools used in milling operations include: 2.1 Drills 2.2 Reamers 2.3 Slitter 2.4 End mills 2.5 Shell mills 2.6 Side and face cutters 2.7 Formed cutter 2.8 T-slot cutter 2.9 Ball end mill 2.10 Engraving 2.11 Dovetail 2.12 Tap 2.13 NC start drill 2.14 Center drill
3. Workpiece	Workpiece materials used in milling operations: 3.1 Ferrous metals 3.2 Non-ferrous metals 3.3 Non – metallic materials
4. Milling Operations	Complex CNC milling operations: 4.1 drilling 4.2 boring 4.3 milling slot and keyways 4.4 milling serrations 4.5 milling vees 4.6 milling circular and rectangular pockets 4.7 milling circular slots 4.8 milling contour 4.9 Tapping 4.10 Reaming 4.11 Engraving 4.12 Chamfering 4.13 4^{th} - axis operation

EVIDENCE GUIDE

1. Critical aspects of evidence	Assessment requires evidence that the candidate: 1.1 determined job requirements 1.2 wrote advanced CNC milling machine program 1.3 edited advanced CNC milling machine programs
2. Underpinning knowledge and attitude	2.1 Drawing interpretation 2.1.1 Standard drawing scales, symbols and abbreviations 2.1.2 Orthographic and isometric drawings 2.1.3 Assembly and detailed drawings 2.1.4 Interpreting tolerances 2.1.5 Geometrical Tolerances (form and position) 2.1.6 Surface condition (surface finish/texture) 2.1.7 limits and fits 2.2 Shop mathematics 2.2.1 Four fundamental operation 2.2.2 Fractions and decimals 2.2.3 Percentages and ratios 2.2.4 Conversion of units (English to metric) 2.2.5 Pythagorean theorem 2.2.6 Basic trigonometric function 2.3 Materials and related science 2.3.1 Classification and mechanical properties of engineering materials 2.4 Milling machine operations 2.4.1 Calculation of cutting speed, rpm, feed rate 2.4.2 Classification/selection of cutting tools and tool geometry 2.4.3 Milling operation processes 2.5 4^{th} axis operation
3. Underpinning skills	3.1 Selection of cutting tools 3.2 Computation of feed, cutting speed and machine rpm 3.3 Application of G – codes and M – codes 3.4 Application of 4^{th} –axis
4. Resource implications	The following resources must be provided 4.1 Drawings, sketches or blueprint/materials 4.2 Computers and simulation software's
5. Method of assessment	Competency must be assessed through: 5.1 direct observation with questioning 5.2 written exam 5.3 demonstration (actual programming)
6. Context for assessment	Competency may be assessed in the workplace or in simulated workplace environment.

UNIT OF COMPETENCY : **Set-up multiple-axis CNC milling machine, workpiece and cutting tools**

UNIT CODE : **MEE821311**

UNIT DESCRIPTOR : This unit covers the knowledge and skills required to set-up CNC milling machine with 3 or more axes and cutting tools, download program, set-up workpiece, dry-run program and perform trial cut on workpiece.

ELEMENTS	PERFORMANCE CRITERIA ***Italicized*** terms are elaborated in the Range of Variables
1 Set up machine and cutting tools	1.1 Oil and coolant is checked according to manufacturer's specification. 1.2 Air and hydraulic pressure is checked according to manufacturer's specification. 1.3 Machine zero point is set to the required position 1.4 ***Cutting Tools*** are set according to required sequence of operations. 1.5 ***Clamping devices*** are tightened according to standard operating procedures. 1.6 ***Tool set-up*** is performed according to standard operating procedures.
2 Download/ inputed program	2.1 Program is downloaded/ inputed to the machine using appropriate devices. 2.2 Program is simulated to determine the correctness of the tool path and other work parameters. 2.3 Workpiece zero point is set to the required position.
3. Set-up workpiece	3.1 ***Workpiece*** is mounted on clamping device to required level of accuracy using tools and ***instruments / equipment*** in accordance with worksite procedures. 3.2 Set-up is performed in accordance with safety procedures and using personal protective devices.
4 Dry-run program	4.1 Dry run is performed in accordance with the desired tool path movement. 4.2 Where necessary, program is edited according to required tool path movement.
5 Perform trial cut on workpiece	5.1 Machined workpiece as programmed. 5.2 Checked and measured workpiece dimensions using appropriate measuring instruments. 5.3 Where required, program is edited and tool parameters are corrected/adjusted.

RANGE OF VARIABLES

VARIABLE	RANGE
1. Cutting Tools	Cutting tools used in CNC milling operations include: 1.1 Drills 1.2 Reamers 1.3 Slitter 1.4 End mills 1.5 Shell mills 1.6 Side and face cutters 1.7 Formed cutter 1.8 T-slot cutter 1.9 Ball end mill 1.10 Engraving 1.11 Dovetail 1.12 Tap 1.13 NC start drill 1.14 Center drill
2. Tool set-up	2.1 Scratch method 2.2 Tool-setting device method
3. Workpiece	Workpiece materials used in turning operations: 3.1 Ferrous metals 3.2 Non-ferrous metals 3.3 Non – metallic materials
4. Work holding and clamping device	4.1 Workholding devices 4.1.1clamps 4.1.2 vises 4.1.3 angle plates 4.1.4 parallel bars 4.1.5 vee-blocks
5. Instruments	5.1 Tool pre - setting device (optional) 5.2 Dial indicator 5.3 Dial test indicator 5.4 Gauges (go-no go, pitch, plug, radius, etc.) 5.5 Coordinate measuring machine (CMM) (optional) 5.6 Bevel protractor 5.7 Profile projector 5.8 Surface-texture tester 5.9 Surface-finish comparator 5.10 Edge finder 5.11 Steel rule 5.12 Bore gage

EVIDENCE GUIDE

1. Critical aspects of evidence	Assessment requires evidence that the candidate: 1.1 Performed machine and cutting tools set-up 1.2 Downloaded/ inputed programs 1.3 Performed workpiece set-up 1.4 Performed program dry run 1.5 Performed trial cut on workpiece
2. Underpinning knowledge and attitude	2.1 Shop safety practices 2.1.1 Safe working habits 2.1.2 Identification of hazardous areas 2.1.3 Protective clothing and devices 2.1.4 Safe handling of tools, equipment and materials 2.1.5 Housekeeping 2.1.6 First-aid 2.1.7 Fire extinguishers 2.2 Measurements 2.2.1 Linear measuring tools (vernier, micrometer) 2.2.2 Angular measuring tools (Vernier bevel protractor) 2.2.3 Geometrical tolerances measuring tools (dial test indicator, radius gauge, vernier height gauge, 2 pt. bore gauge, 3 pt. bore gauge) 2.2.4 Surface finish measuring instrument 2.3 4^{th} axis operation
3. Underpinning skills	3.1 Identification of cutting tools 3.2 Use of measuring instruments 3.3 Determining workpiece specifications 3.4 Scratch method for tool set-up 3.5 Use of tool setter 3.5 Application of 4^{th} axis operation
4. Resource implications	The following resources must be provided 4.1 Tools, equipment and facilities appropriate to processes or activities 4.2 Materials relevant to the proposed activity 4.3 Drawings, sketches or blueprint
5. Method of assessment	Competency must be assessed through: 5.1 direct observation 5.2 demonstration
6. Context for assessment	Competency may be assessed in the workplace or in simulated workplace environment.

UNIT OF COMPETENCY : **Perform Advanced CNC Milling Machine Operations**

UNIT CODE : **MEE821312**

UNIT DESCRIPTOR : This unit covers the skills required to operate CNC milling machine with 3 or more axes. It details the requirements for performing complex CNC milling operations such as drilling, boring, reaming, milling blocks, shoulder, parallel and angled faces, milling slots, keys, serrations, and milling castings and circular slots and externa/internal radius.

ELEMENTS	PERFORMANCE CRITERIA ***Italicized*** terms are elaborated in the Range of Variables
1. Mill workpiece	1.1 Workpiece is mounted or set in accordance with standard operating procedures. 1.2 ***Complex CNC milling operations*** are performed to produce component as programmed. 1.3 ***Corrective measures/adjustments*** are performed if necessary. 1.4 Safety procedures are observed during machining operation.using personal protective devices. 1.5 Personal protective devices are used in accordance with occupational health and safety (OHS) requirements.
2. Check, and measure workpiece	2.1 Workpiece is checked and measured in conformance to specification using appropriate methods, ***measuring tools*** and equipment. 2.2 Defective workpieces are marked, recorded and reported for proper action.

RANGE OF VARIABLES

VARIABLE	RANGE
1. Complex CNC Milling Operations	Complex CNC milling operations 1.1 drilling 1.2 boring 1.3 milling slot and keyways 1.4 milling serrations 1.5 milling vees 1.6 milling circular and rectangular pockets 1.7 milling circular slots 1.8 milling contour 1.9 Tapping 1.10 Reaming 1.11 Engraving 1.12 Chamfering 1.13 4th axis operation
2. Corrective measures/ adjustments	2.1 Replacement of cutting tools 2.2 Adjustment of tool offset 2.3 Adjustment of cutting speed and feed rate
3. Measuring Tools	3.1 Vernier caliper (Digital/ read out) 3.2 Micrometer (Digital/ read out) 3.3 Gages (thread, drill, surface comparator / roughness tester, radius, screw pitch, taper)

EVIDENCE GUIDE

1. Critical aspects of evidence	Assessment requires evidence that the candidate: 1.1 milled workpiece 1.2 checked and measured workpiece
2. Underpinning knowledge and attitude	2.1 Shop safety practices 2.1.1 Safe working habits 2.1.2 Identification of hazardous areas 2.1.3 Protective clothing and devices 2.1.4 Safe handling of tools, equipment and materials 2.1.5 Housekeeping 2.1.6 First-aid 2.1.7 Fire extinguishers 2.2 Drawing interpretation 2.2.1 Standard drawing scales, symbols and abbreviations 2.2.2 Orthographic and isometric drawings 2.2.3 1st and 3rd angle projections 2.2.4 Assembly and detail drawings 2.2.5 Interpreting tolerances, limits and fits 2.2.6 Surface finish 2.3 Shop mathematics 2.3.1 Basic arithmetic operations 2.3.2 Fractions and decimals 2.3.3 Percentages and ratios 2.3.4 Conversion of units (English to metric) 2.3.5 Trigonometric functions 2.3.6 Pythagorean theorem 2.4 Measurements 2.4.1 Linear measuring tools (vernier, micrometer) 2.4.2 Precision angular measuring tools (Vernier bevel protractor) 2.4.3 Geometrical tolerances measuring tools (dial test indicator, radius gauge, vernier height gauge, 2 pt. bore gauge, 3 pt. bore gauge) 2.4.4 Dial indicator 2.5 Materials and related science 2.5.1 Classification and mechanical properties of engineering materials 2.6 CNC Milling operations: 2.6.1 Milling types and specifications 2.6.2 Milling machine parts and functions 2.6.3 Milling cutters and holders 2.6.4 Setting rpm, feed rate 2.6.5 Workholding devices 2.6.6 Milling machine accessories, fixtures and attachments 2.6.7 4th axis operation

3. Underpinning skills	3.1 Selection of cutting tools 3.2 Use of measuring instruments 3.3 Determining workpiece specifications 3.4 Computation of feed machine rpm 3.5 Application of G – codes and M – codes 3.6 Application of 4^{th} axis operation
4. Resource implications	The following resources must be provided: 4.1 Tools, equipment and facilities appropriate to processes or activities 4.2 Materials relevant to the proposed activity 4.3 Drawings, sketches or blueprint
5. Method of assessment	Competency must be assessed through: 5.1 Direct observation with questioning 5.2 Written exam 5.3 Demonstration
6. Context for assessment	Competency may be assessed in the workplace or in simulated workplace environment.

SECTION 3 TRAINING STANDARDS

These guidelines are set to provide the Technical and Vocational Education and Training (TVET) providers with information and other important requirements to consider when designing training programs for CNC MILLING MACHINE OPERATION NC III.

3.1 CURRICULUM DESIGN

Course Title: CNC MILLING MACHINE OPERATION **NC Level:** NC III

Training Duration: **24** Hours (Basic)
130 Hours (Common)
80 Hours (Core)
234 Hours

Course Description:

This qualification is designed to develop knowledge, desirable attitudes and skills in CNC Milling Machine Operation NC III.

It covers the competencies required to write advanced CNC milling machine program, set-up machine, workpiece and cutting tools and perform advanced CNC milling machine operations.

To obtain this, all units of competency prescribed for this qualification must be achieved.

BASIC COMPETENCIES

Unit of Competency	Learning Outcomes	Methodology	Assessment Approach
1. Lead workplace communication	1.1 Communicate information about workplace processes 1.2 Lead workplace discussions Identify and communicate issues arising in the workplace	• Group discussion • Interaction	• Demonstration • Observation • Interviews/ Questioning
2. Lead small teams	2.1 Provide team leadership 2.2 Assign responsibilities 2.3 Set performance expectations for team members 2.4 Supervised team performance	• Group discussion • Interaction	• Demonstration • Observation • Interviews/ Questioning

Unit of Competency	Learning Outcomes	Methodology	Assessment Approach
3. Develop and practice negotiation skills	3.1 Plan negotiations 3.2 Participate in negotiations	• Group discussion • Interaction	• Demonstration • Observation • Interviews/ Questioning
4. Solve problems related to work activities	4.1 Identify the problem 4.2 Determine fundamental causes of the problem 4.3 Determine corrective action 4.4 Provide recommendation/s to manager	• Group discussion • Interaction	• Demonstration • Observation • Interviews/ Questioning
5. Use mathematical concepts and techniques	5.1 Identify mathematical tools and techniques to solve problem 5.2 Apply procedure / solution 5.3 Analyze results	• Group discussion • Interaction	• Demonstration • Observation • Interviews/ Questioning
6. Use relevant technologies	6.1 Study / select appropriate technology 6.2 Apply relevant technology 6.3 Maintain / enhance relevant technology	• Group discussion • Interaction	• Demonstration • Observation • Interviews/ questioning

COMMON COMPETENCIES

Unit of Competency	Learning Outcomes	Methodology	Assessment Approach
1. Apply safety practices	1.1 Identify hazards 1.2 Use protective clothing and devices 1.3 Perform safe handling of tools, equipment and materials 1.4 Perform first aid 1.5 Use fire extinguisher	• Lecture • Group discussion • Interaction • Role playing / Simulation	• Observation • Demonstration • Interview / Questioning
2. Interpret working drawing and sketches	2.1 Interpret technical drawing 2.2 Prepare freehand sketch of parts 2.3 Interpret details from freehand sketch	• Lecture • Group discussion • Interaction	• Observation • Interview / Questioning

Unit of Competency	Learning Outcomes	Methodology	Assessment Approach
3. Select / cut workshop materials	3.1 Determine requirement 3.2 Select and measure materials 3.3 Cut materials	• Lecture • Demonstration • Practical exercise	• Demonstration • Observation • Performance test • Interview / Questioning
4. Perform shop computations (Basic)	4.1 Perform four fundamentals operations 4.2 Perform basic calculations involving fractions and decimals 4.3 Perform basic calculations involving percentages 4.4 Perform basic calculation involving ration and proportion 4.5 Perform calculations on algebraic expressions	• Lecture • Demonstration • Practical exercise	• Demonstration • Observation • Performance test • Interview / Questioning
5. Measure workpiece (Basic)	5.1 Select and use measuring tools 5.2 Clean and store measuring tools	• Lecture • Demonstration • Practical exercise	• Demonstration • Observation • Performance test • Interview / Questioning
6. Perform routine housekeeping	6.1 Organize work area 6.2 Clean Work area	• Lecture • Group discussion • Simulation • Practical exercise	• Demonstration • Observation • Performance test • Interview / Questioning
7. Perform Shop computations (Intermediate)	7.1 Perform calculations involving triangles 7.2 Calculate taper	• Lecture • Demonstration • Practical exercise	• Demonstration • Observation • Performance test • Interview / Questioning

Unit of Competency	Learning Outcomes	Methodology	Assessment Approach
8. Measure workpiece using angular measuring instruments	8.1 Select and use angular measuring tools 8.2 Maintain angular measuring tools 8.3 Clean and store measuring Tools	• Lecture • Demonstration • Practical exercise	• Demonstration • Observation • Performance test • Interview / Questioning
9. Perform shop Computation (Advanced)	9.1 Calculate gear ratio 9.2 Solve indexing problems 9.3 Solve gearing problems 9.4 Use geometrical principles in the solution of problems	• Lecture • Demonstration • Practical exercise	• Demonstration • Observation • Performance test • Interview / Questioning
10. Measure workpiece using gages and surface texture comparator	10.1 Select and use fixed and adjustable gages 10.2 Perform surface texture measurements 10.3 Clean and store measuring tools	• Lecture • Demonstration • Practical exercise	• Demonstration • Observation • Performance test • Interview / Questioning
11. Perform preventive and corrective maintenance	11.1 Perform inspection of machine 11.2 Perform cleaning and lubricating of machine 11.3 Perform minor machine repair and adjustments 11.4 Maintain hand tools	• Lecture • Demonstration • Group discussion • Practical exercise	• Demonstration • Observation • Performance test • Interview / Questioning
12. Prepare cost estimate	12.1 Determine customer requirements 12.2 Estimate cost components 12.3 Cost the job 12.4 Verify and document costs	• Group discussion • Interaction	• Demonstration • Observation • Interviews/ Questioning

CORE COMPETENCIES

Unit of Competency	Learning Outcomes	Methodology	Assessment Approach
1. Write advanced CNC milling machine program	1.1 Determine job requirements 1.2 Write Advanced CNC milling machine program 1.3 Edit Advanced CNC milling machine programs	• Lecture • Group Discussion/ interaction	• Observation • Interview • Interview/ Questioning
2. Set-up multiple-axis CNC milling machine, workpiece and cutting tools	2.1 Set-up machine, workpiece and cutting tools 2.2 download program 2.3 Set-up workpiece 2.4 Dry-run program 2.5 Performed trial cut on workpiece	• Lecture • Demonstration • Practical exercise	• Demonstration • Observation • Performance test • Interview/ Questioning
3 Perform advanced CNC milling machine operations	3.1 Turn workpiece 3.2 Check and measure workpiece	• Lecture • Demonstration • Practical exercise	• Demonstration • Observation • Performance test • Interview/ Questioning

3.2 TRAINING DELIVERY

The delivery of training should adhere to the design of the curriculum. Delivery should be guided by the 10 basic principles of competency-based TVET.

- The training is based on curriculum developed from the competency standards;
- Learning is modular in its structure;
- Training delivery is individualized and self-paced;
- Training is based on work that must be performed;
- Training materials are directly related to the competency standards and the curriculum modules;
- Assessment is based in the collection of evidence of the performance of work to the industry required standard;
- Training is based both on and off-the-job components;
- Allows for recognition of prior learning (RPL) or current competencies;
- Training allows for multiple entry and exit; and
- Approved training programs are Nationally Accredited

The competency-based TVET system recognizes various types of delivery modes, both on and off-the-job as long as the learning is driven by the competency standards specified by the industry. The following training modalities may be adopted when designing training programs:

- The dualized mode of training delivery is preferred and recommended. Thus programs would contain both in-school and in-industry training or fieldwork components. Details can be referred to the Dual Training System (DTS) Implementing Rules and Regulations.
- Modular/self-paced learning is a competency-based training modality wherein the trainee is allowed to progress at his own pace. The trainer just facilitates the training delivery.
- Peer teaching/mentoring is a training modality wherein fast learners are given the opportunity to assist the slow learners.
- Supervised industry training or on-the-job training is an approach in training designed to enhance the knowledge and skills of the trainee through actual experience in the workplace to acquire specific competencies prescribed in the training regulations.
- Distance learning is a formal education process in which majority of the instruction occurs when the students and instructor are not in the same place. Distance learning may employ correspondence study, audio, video or computer technologies.

3.3 TRAINEE ENTRY REQUIREMENTS

This section specifies the qualifications of trainees and their educational attainment. Other requirements like health and physical requirements are also stated. Passing entry written entrance examinations may also be indicated if necessary.

- Must be high school graduate
- Able to communicate in writing
- Physically and mentally fit ; and
- Must be a holder of CNC Milling Machine Operation NC II

3.4 LIST OF TOOLS, EQUIPMENT AND MATERIALS CNC MILLING MACHINE OPERATION NC III

Recommended list of tools, equipment and materials for the training of 16 trainees for CNC Milling Machine Operation NC III

EQUIPMENT			
QTY	**Description**	**QTY**	**Description**
8 units	3-axis CNC Milling Machine with complete standard accessories	1 unit	4 or more axes CNC Milling Machine
1 unit	OHP/LCD Projector	1 unit	Power Hack saw

SUPPLIES AND MATERIALS			
QTY	**Description**	**QTY**	**Description**
2 pcs.	Aluminum bar 50x50mm x 5m, T6	2 pcs.	Aluminum bar 50 x100mm x 5m, T6
1 pc.	Aluminum Flat bar 60 x 100mm x 5m, T6	2 pcs.	MS Square bar 50x50mm x 6m
2 pcs.	MS plate 50 x100mm x 2.4m	16 pcs.	Paint brush 50 mm width
16 pcs.	256 mb flash drive	3 boxes	Whiteboard marker Black, Blue and red color
10 kgs.	Rags		

TRAINING MATERIALS			
QTY	**Description**	**QTY**	**Description**
8 pcs.	Teachers Guide	6 pcs.	Manuals
16 pcs.	CNC simulation software		Reference books
	Catalogs		Brochures
	Modules/ LEs		CDs/ Video tapes
	Handouts		

TOOLS					
				TRAINING MATERIALS	
QTY	Description	QTY	Description	QTY	DESCRIPTION
8 pcs.	Staggered tooth side cutter dia. 36mm x 5mm	32 pcs.	End Mill 4, 6, 8, 10, 12, 16 mm dia	8 pcs. each	Ball nose endmill, 3, 6, 8, 10, 12mm
3 pcs. each	Face Mill, 40, 50, 63 mm dia.	3 sets	Hand Tap M6, M8, M10, M12	8 pcs.	NC start drill 10mm dia.
8 pcs.	Dovetail cutter, 16 mm dia.	6 boxes	Drill bit dia.1mm-13mm set	8 pcs. each	Machine tap M5, M6, M8, M10 , M12
16 pcs.	Center drill # 2	8 pcs.	Slot cutter dia. 16 mm	8 sets	Engraving Tool
8 pcs.	Edge finder	2 sets	Needle File	8 pcs.	Flat File, 2nd cut, 150 mm
8 pcs.	Rubber mallet	1 set	Letter punch	2 pcs.	Ball peen hammer, 0.5 kgs

MEASURING INSTRUMENTS					
QTY	Description				
8 pcs.	Vernier caliper (Digital) 150mm	8 pcs.	Micrometer (Digital) 0- 25 mm	8 pcs.	Dial indicator with magnetic stand, lever-type, 0.01 least count
1 pc.	Bevel protractor	1 pc.	Thread pitch gage	1 set	Gage block (optional)
1 pc.	Vernier height gage with dial indicator (optional)				

3.5 TRAINING FACILITIES
CNC MILLING MACHINE OPERATION NC III

The CNC Machining workshop must be of concrete structure for 16 trainees. The space requirements for the teaching/learning and circulation areas are as follows:

SPACE REQUIREMENT	SIZE IN METERS	AREA IN SQ. METERS	TOTAL AREA IN SQ. METERS
• Building (Permanent)	79M x 25M		1,975 sq. M
• CNC Basic Turning workshop	10.0M x 5.5M	55 sq. M	55 sq. M
• CNC Intermediate and Production workshop	7.5M x 11.0M	82.5 sq. M	82.5 sq. M
• Quality Control room	10.0M x 11.0M	110 sq. M	110 sq. M
• Learning Resource Center	5.0M x 5.0M	25 sq. M	25 sq. M
• Audio Visual room	5.0M x5.0M	25 sq. M	25 sq. M
• Tool Room and Storage	10.0M x 11.0M	110 sq M	110 sq M
• Metrology room	7.0M x 11.0M	70 sq. M	70 sq. M

3.6 TRAINER'S QUALIFICATIONS FOR CNC MILLING MACHINE OPERATION NC III

TRAINER QUALIFICATION (TQ II)

- Must be a holder of CNC Milling Machine Operation NC III or equivalent qualification.
- Must have undergone training on Training Methodology II (TM II) or equivalent in training/ experience
- Must be computer literate
- Must be physically and mentally fit
- *Must have at least 2 years job/industry experience
- Must be a civil service eligible (for government position or appropriate professional license issued by the Professional Regulatory Commission)

*** Optional. Only when required by the hiring institution.**

Reference: TESDA Board Resolution No. 2004 03

3.7 INSTITUTIONAL ASSESSMENT

Institutional assessment is undertaken by trainees to determine their achievement of units of competency. A certificate of achievement is issued for each unit of competency
.

SECTION 4: NATIONAL ASSESSMENT AND CERTIFICATION ARRANGEMENTS

4.1 To attain the National Qualification of CNC Milling Machine Operation NC III, the candidate must demonstrate competence in all the units listed in Section 1. Successful candidates shall be awarded a National Certificate signed by the TESDA Director General.

4.2 The qualification of CNC milling Machine Operation NC III may be attained through:

4.2.1 Accumulation of Certificates of Competency (COCs) in all the following units of competencies:

4.2.1.1 Write advanced CNC milling machine program
4.2.1.2 Set-up multiple-axis CNC milling machine, workpiece and cutting tools
4.2.1.3 Perform advanced CNC milling machine operations

Successful candidates shall be awarded a Certificate of Competency (COC) in each of the core units.

4.2.2 Demonstration of competence through project-type assessment covering all the units required in the qualification.

4.3 Accumulation and submission of all COCs acquired for the relevant units of competency comprising a qualification, an individual shall be issued the corresponding National Certificate.

4.4 Assessment shall focus on the core units of competency. The basic and common units shall be integrated or assessed concurrently with the core units.

4.5 The following are qualified to apply for assessment and certification:

4.5.1. Holder of CNC Milling Machine Operation NC II or equivalent qualification; or

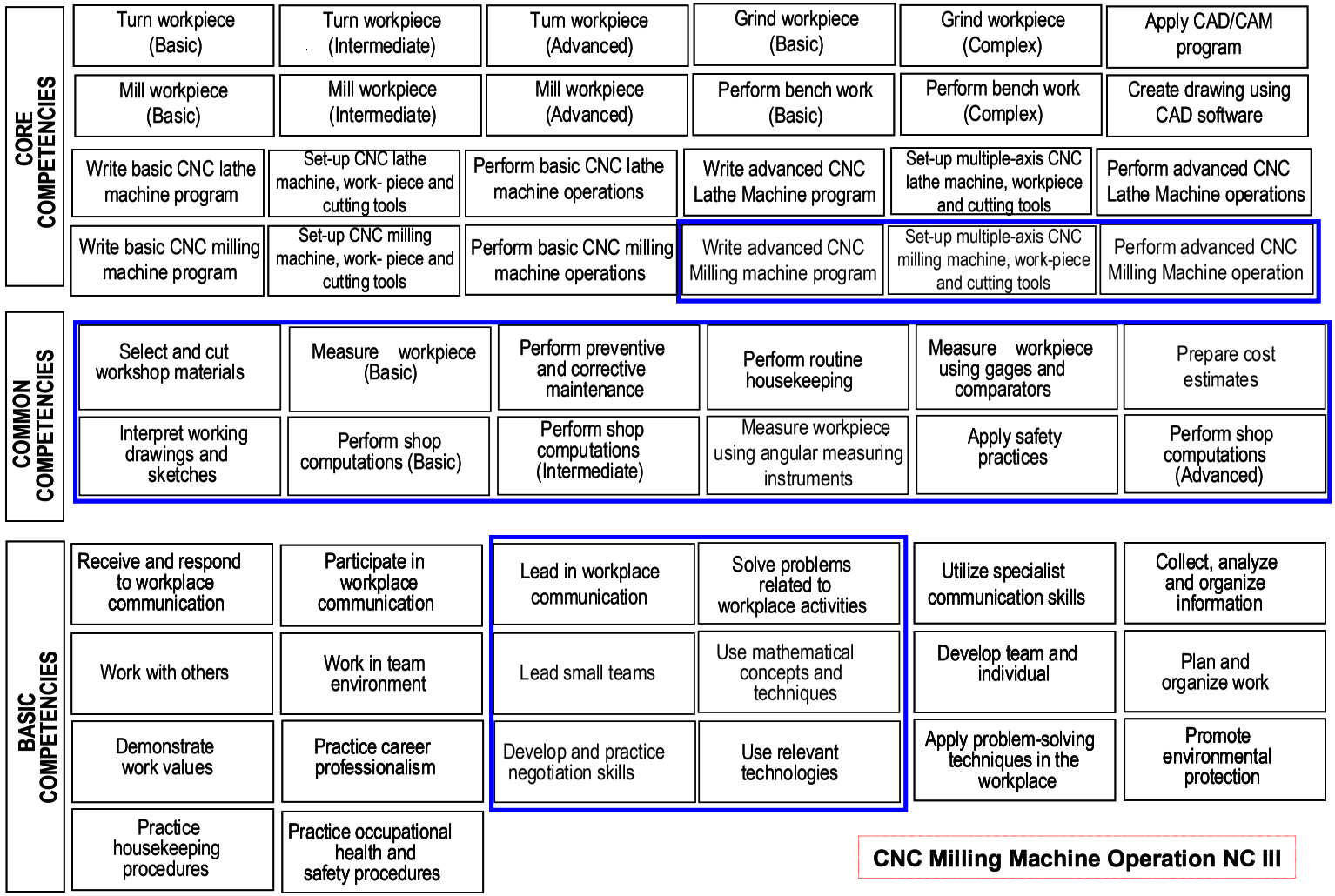
4.5.2. Graduate of formal, non-formal, and informal including enterprise-based training programs.

4.5.3. Experienced workers (wage employed or self employed)

4.6 The guidelines on assessment and certification are discussed in detail in the "Procedures Manual on Assessment and Certification" *and "Guidelines on the Implementation of the Philippine TVET Qualification and Certification System* **(PTQCS)".**

Competency Map

Metals and Engineering Sector



CNC Milling Machine Operation NC III

Definition of Terms

bench work	the operations incident to the process of laying out, fitting, assembling, etc… when the work is placed on the bench or in a bench vise
boring	is the operation of enlarging a hole by means of an adjustable cutting tool with only one cutting edge
chipping	is the operation of removing/cutting metal using hammer and chisel
counter boring	is the operation of enlarging the end of a hole cylindrically
drilling	is the operation of producing a circular hole by removing solid metal
facing	the lathe operation of finishing the ends of the work, to make the piece the right length. Also known as squaring
grinding	refers to the removal of material from a workpiece with grinding wheel
laying out	term used to include the marking or scribling of center points, circles, arcs, or straight lines upon metal surfaces, either curved or flat, for the guidance of the worker
milling	refers to removal of metal by feeding a workpiece through the periphery of rotating circular cutter
reaming	is an operation of sizing and finishing a hole by means of a cutting tool having several cutting edges. reaming serves to make the hole smoother, straighter, and more accurate
spot-facing	is the operation of smoothing and squaring the surface around a hole
tapping	is the operation of forming internal threads by means of a tool called tap
turning	refers to shaping a workpiece by gripping it in a workholding device and rotating it under power against a suitable cutting tool
CNC machining	refers to the fabrication of work piece either turning, milling or any other machining process with the use of **C**omputerized **N**umerically **C**ontrolled machine tools
programming	the process of coding machining conditions in which informations such as cutter dimensions, cutter movement , processing orders, federate or spindle speed all under fixed regulation or specified format which refers to the workpiece drawing to instruct **N**umerically **C**ontrolled machine tool
CAD	**C**omputer **A**ided **D**esign – the use of graphics-oriented computer software for designing and drafting applications
CAM	**C**omputer **A**ided **M**anufacturing- computer software that generates programs for the operation of NC (numerical control) machine tools

ACKNOWLEDGEMENTS

The Technical Education and Skills Development Authority (TESDA) wishes to extend thanks and appreciation to the many representatives of business, industry, academe and government agencies who rendered their time and expertise to the development and validation of these Training Regulations.

INDUSTRY EXPERTS:

DR. FELICIANO JAPITANA Chief, MWTD Metal Industry Research and Development Center	**Engr. ROGELITO AQUINO** Engineer III, MSFS Metal Industry Research and Development Center
RAMON MARTIN CNC Expert Metal Industry Research and Development Center	**HECTOR D. MALONZO** President HDM Technologies, Inc.
ALANO CABANBAN	**VICTORIANO YAP** SME
CHARLIE POLICARPIO SME	**OSCAR UNAS** SME
TIMOTEO INTALAN Metalworking Industries Association of the Philippines, Inc.	**ANTONIO TERANIA** Metalworking Industries Association of the Philippines, Inc.
VIRGILIO LANZUELA President / General Manager VL Industech Corporation	**ENRIQUE PINGOL** PAA

TECHNICAL EXPERTS:

CHARLES A. ANTONIO CEMMT Trainer TTCTCE	**MODESTO A. VELASQUEZ Jr.** CEMMT Trainer TTCTCE
FERDINAND E. ESTACIO Supervising TESD Specialist / Trainer NTTA	**RAMON R. SANTIAGO** CEMMT Trainer TTCTCE
LORENZO A. LADIA Trainer NTTA	**NOEL K. MALABAGO** CEMMT Trainer TESDA – RTC
GIL D. GONZALES CEMMT Focal Person TESDA – RTC XI	**PABLO H. CORTEZ Jr.** CEMMT Focal Person TESDA – RTC VI
ROGEL M. BORBON CEMMT Trainer TESDA – RTC	**JIMMY NILLAS** CEMMT Trainer/ MIAP TESDA – RTC VII
EMILIA B. MAGAAN CEMMT Trainer TESDA – RTC IV-A	**JULFORD C. ABASOLO** Supervising TESD Specialist TTCTCE

Members of the TESDA Board

TESDA EXCOM

The MANAGEMENT and STAFF of the TESDA Secretariat

- Qualification and Standards Office (QSO)