

**WORLD SKILLS SINGAPORE 2023**  
**TECHNICAL DESCRIPTION**  
**CNC MILLING**



**Skill Competition**

1. This competition covers the processing of work pieces through metal cutting with CNC milling machines.
2. Part programming through CNC control and a CAD/CAM software.
3. Conducted as an individual event, competitors are given 19 hours over 3 days to complete the Test Projects for this competition.

**Scope of Work**

4. Competitors must be able to demonstrate competencies in the following areas:
  - 4.1. Write CNC programs based on drawings using MASTERCAM software
  - 4.2. Select, mount and set-up tools independently
  - 4.3. Enter tool data at the machine
  - 4.4. Set-up and operate a CNC milling machine to produce precision components to specifications
  - 4.5. Produce components to dimensional accuracy of up to International Tolerance (IT) 7, geometrical tolerance of form and position within 0.02 mm, and surface roughness of Ra 0.8 to Ra 1.6
  - 4.6. Interpret technical drawings in accordance with international drawing standards (first angle and third angle projections)
  - 4.7. Apply knowledge of materials used and the appropriate cutting conditions
  - 4.8. Apply knowledge of CNC milling programming written with G-codes, M-codes and canned-cycles
  - 4.9. Apply knowledge of programming using a CAM software
  - 4.10. Apply knowledge and follow the safety instructions at **Appendix I** when working with a CNC machine tool
  - 4.11. Work on 3D STEP file
  - 4.12. Assemble components

**Technical Support**

5. Training will be provided on the competition machine (maximum 10 working days) prior to the competition. Technicians will be on site to familiarize competitors with the machine's functions and processes. Competitors not

*The organisers reserve the right to update the Technical Description whenever necessary*

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familiar with the competition machines are encouraged to attend the training to reduce the risk of injury to themselves and damage to the machines.

6. The specialists and services staff for the CAM software and the CNC milling machines will be available at all times on competition site to ensure that the competition runs smoothly.

**Assessment**

7. Competitors will be assessed based on measurement (objective) and judgement (subjective) marking.
8. The assessment criteria and relative weighting of marks are as follows:

<b>Criterion</b>		<b>Marks</b>
A	Main dimensions	50
B	Secondary dimensions	25
C	Surface quality	10
D	Conformity with drawing	10
E	No additional material used	5
<b>Total</b>		<b>100</b>

**Major Tools & Materials**

9. The following tools and materials will be used in the competition:
  - 9.1. Measuring Tools
    - a) Outside micrometers (0~150 mm)
    - b) Depth micrometer (0~75 mm)
    - c) Disc micrometer (0~25mm, 25~50mm)
    - d) 3-point hole micrometers (5~25mm, 25~50mm)
    - e) Inside micrometers (5~25mm, 25~50mm)
    - f) Vernier caliper (0~150 mm)
    - g) Depth Vernier caliper (0~15mm)
    - h) Dial indicator with magnetic stand
    - i) Dial test indicator with adjustable holder
    - j) Portable surface roughness tester
    - k) Slip gauges set
    - l) Thread Plug Gauges for good and rejected products (M6 x 1.0 mm, M10 x 1.5 mm, M30 x 1.5 mm)

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- m) Thread Ring Gauge (M30 x 1.5 mm, OD 64 x 8 mm, M30 x 1.5 mm, OD 64 x 18 mm, M42 x 1.5, OD 85 mm x 8 mm, M42 x 1.5, OD 85 mm x 18 mm)
- n) Plug Gauge (Ø6H7 mm, Ø8H7 mm, Ø10H7 mm)
- o) Radius gauge (R3~25 mm)
- p) Digital height gauge (0~300 mm)

#### 9.2. Cutting Tools and Holder

- a) Carbide face mill (Ø63 mm)
- b) Carbide insert for face mill
- c) Roughing endmill (Ø6x13 mm, Ø8x19 mm, Ø10x22 mm, Ø12x26 mm, Ø16x32 mm, Ø20x38 mm)
- d) Finishing endmill (Ø6x13 mm, Ø8x19 mm, Ø10x22 mm, Ø12x26 mm, Ø16x32 mm, Ø20x38 mm)
- e) Ball nose endmill (Ø12 mm)
- f) Drill set (Ø1 mm to Ø12 mm)
- g) Drills (Ø5 mm, Ø8.5 mm, Ø9.8 mm, Ø10.0 mm, Ø11.8 mm and Ø20.0 mm)
- h) NC Centre drill 90° (Ø10 mm)
- i) Machine Reamer (Ø6H7 mm, Ø8H7 mm, Ø10H7 mm)
- j) Chamfering cutter 90° (Ø10 mm)
- k) Internal thread mill, pitch 1.5 mm (M30 x 1.5 mm, max length to cut = 45 mm)
- l) External thread mill, pitch 1.5 mm (M42 x 1.5 mm, external Dia 13 mm, max length to cut = 20 mm)
- m) Machine tap (blind hole) (M6 x 1 mm and M10 x 1.5 mm)
- n) Machine tap (through hole) (M6 x 1 mm and M10 x 1.5 mm)
- o) Boring head (Ø20 mm to Ø30 mm)
- p) Right-angle milling head (Ø20 mm and Ø50 mm)
- q) Spare reversible carbide tips

#### 9.3. Equipment/Accessories

- a) CNC Milling machine with machine controller and standard accessories, machine vice of 150 mm jaw width, 50 mm jaw depth, 250 mm clamping range
- b) Work bench for tool assembly
- c) A set of parallel bars
- d) Touch probe
- e) Machine vice

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- f) External size of toolbox must be within 1.2m<sup>3</sup>. Maximum number of toolboxes allowed is two units. Total volume of all toolboxes combined must be within 2m<sup>3</sup>

9.4. **Materials**

- a) Aluminum (6 series, good machinability quality) shall not exceed 150 mm x 100 mm x 55 mm (+0.5 mm / -0), machined all six faces
- b) Medium carbon steel (equivalent to AISI/DIN Standard) shall not exceed 150 mm x 100 mm x 50 mm (+0.5 mm / -0) and 100 mm x 55 mm x 55 mm (2 pieces / set, +0.5 mm / -0), machined all six faces
- c) Dowel pins: Dia 6 x 12 mm (2 pieces / set)

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**Appendix I**

**Safety Regulations**

The following safety instructions should be followed when working with a CNC machine tool.

**Before beginning work:**

- Orientation of work area including thorough machine familiarization must be done prior to competition.
- Before beginning work, check the location of the origin and the tool compensation. The origin and tool compensation should be carefully entered in the offset area reserved for them.
- The machine tool must be allowed to run for a couple of minutes before machining begins.
- Make sure that the machined material and tools are securely fastened before beginning work.
- Perform test runs with the CNC machine (single block - dry run) at rapid reduction 25%.
- Secure long hair from entangling with the rotating cutter.

**During work:**

- Always keep the doors of the CNC machine closed when machining – the use of “door hold override” is prohibited.
- Use a brush or cleaning tool to remove chips from the machine.
- Keep feedrates and RPM within acceptable limits.

**After work:**

- Stop the machine before removing chips from inside the machine and the working area.
- Switch off the machine unless otherwise instructed.
- If grease or cutting fluid reaches the floor, it must be cleaned up immediately.

**Emergencies:**

- If there is unusual sounds or noise, stop the machine and report the noise to the shop master or nearest judge immediately.
- Should an accident occur, press the emergency stop button and contact the shop master or nearest judge immediately.

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**Safety:**

- Familiarize with the machine's user manual and safety regulations.
- Always use eye protection.
- Make sure that the piece is properly fastened and that the fastenings do not block the milling.
- Make sure spindle is not rotating when performing measurements and removing chips.
- Never remove chips by hand or pneumatically.
- Beware of using too fast a feed movement towards the piece.
- Do not use air gun to blow against any part of your body.