



Module

# Fabrication of mechanical components by machining

MD 02

**GDVT**

**gtz**



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Training module:  
**Fabrication of mechanical components by machining**

**Code of Module: MD02**

**Time: 120 h.**

(Theory: 34h; Practice: 86h)

**I. Position and characteristics of the module**

- The overall idea of this module is the production of a mechanical qualification project, for example a sub-assembly, by machining.
- The sub-assembly consists of several work pieces, which are to be assembled and checked for function. Each work piece contains specific skills to be trained. From special importance is the fact, that all work pieces have to fit together, thus emphasizing the importance of accuracy, tolerances and fits.
- Every work piece, as well as the complete sub-assembly, is to be produced in such a way, that the trainee will be qualified for independent planning, conduction and checking of his work.
- The following module-structure and the contents are derived from the qualification project “pick and place device” from the South Westfalia Chamber of Commerce and Industry, Germany.
- The module could follow other qualification projects if they contain the same objectives and comparable contents.
- Before this module is implemented, the trainee should have skills and experience in manual production, material science and technical drawing.

**II. Objectives of the module**

After finishing this module, the trainees are able to;

- Determine working steps for production of work pieces and assemblies according to functional, manufacturing and economical criteria.
- Describe manufacturing processes (turning, milling, drilling, grinding) and their characteristics (movements of work piece and tool, reachable accuracy).
- Read and use engineering drawings of components and sub-assemblies.
- Determine tolerances, fits and surface finish from technical drawings and observe for production.
- Select and operate measuring instruments for lengths (accuracy of 0.01mm) and angles (accuracy up to 5´).
- Check parallelism of surface and concentricity with dial gauges.
- Describe ISO-system of fits, determine limit deviations and check dimensions with limit plug gauges and external limit gauges.

- Scribe, centre-punch and mark work pieces under consideration of properties of materials.
- Select and fasten clamping tools in accordance with size, form, working material and the machining of work pieces for drilling, milling and turning.
- Align and hold work pieces with machine vices, clamping jaws, step-blocks, three jawed chucks and centres with particular attention to work piece stability and surface protection.
- Align and hold tools with chucks, clamping cones, holding clamps and tool-holders.
- Develop working plans for production of components according to given work order.
- Select and provide tools according to production method and work order, type of material (work piece and cutting material) and cutting edge geometry.
- Determine and set speed of revolution, feed and depth of cut on machine tools for drilling/boring, turning and milling operations with the aid of tables and diagrams.
- Prepare machine tools for operation
- Produce holes in work pieces up to a positional tolerance of  $\pm 0.2\text{mm}$  on drilling machines, including profile holes by countersinking and counterboring, fit holes up to a dimensional accuracy IT 7 by circular reaming and tapping
- Produce work pieces of ferrous and non-ferrous metals by turning up to a dimensional accuracy of  $\pm 0,05\text{ mm}$  and surface finish  $R_z 25\ \mu\text{m}$  by transverse and longitudinal facing, longitudinal turning, internal turning, transverse cut-off turning and form turning (chamfer, radii, taper, thread).
- Produce work pieces of ferrous and non-ferrous metals by milling up to a dimensional accuracy of  $\pm 0,05\text{ mm}$  and a surface finish  $R_z 25\ \mu\text{m}$  by horizontal and vertical face milling, groove and slot milling.
- Join work pieces by bolted/screwed and pin connections, fits and keys.
- Arrange their work place functional, safe and accessible.
- Read components-lists, assign designations to components and select components from catalogues.
- Describe and follow safety regulations, particularly those arising from operation of drilling machines, lathes and milling machines.
- Specify environmental pollution at workplace and contribute to its reduction.
- Communicate with partners (customers, suppliers and colleagues)
- Develop readiness for self learning to improve knowledge and working skills.
- Solve problems systematically in a team.

### III. Contents of the module

#### 1. Content overview and time allocation:

No.	Name of lesson in the module	Duration			
		Sum	Theory	Practice	Tests
1	Basic skills turning 1 – step shaft	10	5	5	0
2	Basic skills turning 2 - arbor	10	3	7	0
3	Turning piston rod	8	2	6	0
4	Turning piston	4	1	3	0
5	Turning cylinder housing	8	2	6	0
6	Manufacturing of mounting plate	6	2	4	0
7	Assembling of cylinder	4	1	3	0
8	Basic skills milling 1 – Guiding plate	12	4	8	0
9	Basic skills milling 2 - Housing	12	4	8	0
10	Cutting guide block	8	2	6	0
11	Milling of guide frame	12	2	10	0
12	Milling of guide carriage	10	2	8	0
13	Mounting sub-assembly 3 – vertical guide	6	2	4	0
14	Module examination	10	2	8	10

## 2. Detailed contents:

### Lesson 1: Basic skills turning 1 – Step shaft

(10h)

#### Objectives:

After finishing this lesson, the trainees are able to;

- Determine working steps for production of work pieces and assemblies according to functional, manufacturing and economical criteria.
- Describe manufacturing processes (turning, milling, drilling, grinding) and their characteristics (movements of work piece and tool, reachable accuracy).
- Read and use engineering drawings of components and sub-assemblies.
- Determine tolerances, fits and surface finish from technical drawings and observe for production.
- Select and operate measuring instruments for lengths (accuracy of 0.01mm)
- Select and fasten clamping tools in accordance with size, form, working material and the machining of work pieces for turning.
- Align and hold work pieces with three jawed chucks with particular attention to work piece stability and surface protection.
- Align and hold tools with on a lathe with tool-holders.
- Develop working plans for production of components according to given work order.

- Select and provide tools for turning according to production method and work order, type of material (work piece and cutting material) and cutting edge geometry.
- Determine and set speed of revolution, feed and depth of cut on lathe with the aid of tables and diagrams.
- Prepare lathe for operation
- Produce work pieces of ferrous and non-ferrous metals by turning up to a dimensional accuracy of  $\pm 0,05$  mm and surface finish Rz 25  $\mu\text{m}$  by transverse and longitudinal facing, longitudinal turning, internal turning, transverse cut-off turning and form turning (chamfer, radii, taper, thread).
- Arrange their work place functional, safe and accessible.
- Describe and follow safety regulations, particularly those arising from operation of lathes.
- Specify environmental pollution at workplace and contribute to its reduction.
- Develop readiness for self learning to improve knowledge and working skills.

*Content:*

- 1.1 Technical parts drawing
- 1.2 Working plan
- 1.3 Clamping work pieces with three-jawed chuck
- 1.4 Lathe tools
- 1.5 Clamping and aligning of lathe tools
- 1.6 Transverse facing, roughing
- 1.7 Turning of shoulders, roughing
- 1.8 Turning of chamfer
- 1.9 Finishing of right side of work piece
- 1.10 Rechucking of work pieces
- 1.11 Turning left side of work piece
- 1.12 Checking and measuring

**Lesson 2:**

**Basic skills turning 2 – Arbor**

(10h)

*Objectives:*

After finishing this lesson, the trainees are able to;

- Determine working steps for production of work pieces and assemblies according to functional, manufacturing and economical criteria.
- Read and use engineering drawings of components and sub-assemblies.
- Determine tolerances, fits and surface finish from technical drawings and observe for production.
- Select and operate measuring instruments for lengths (accuracy of 0.01mm)

- Select and fasten centres in the spindle and tailstock of a lathe.
- Align and hold work pieces with three jawed chucks and centres with particular attention to work piece stability and surface protection.
- Align and hold tools with chucks and tool-holders.
- Develop working plans for production of components according to given work order.
- Select and provide lathe tools according to production method and work order, type of material (work piece and cutting material) and cutting edge geometry.
- Determine and set speed of revolution, feed and depth of cut on machine tools for turning operations with the aid of tables and diagrams.
- Prepare machine tools for operation
- Produce work pieces of ferrous metals by turning up to a dimensional accuracy of  $\pm 0,05$  mm and surface finish Rz 25  $\mu\text{m}$  by transverse and longitudinal facing, longitudinal turning and form turning (chamfer, ring groove).
- Arrange their work place functional, safe and accessible.

*Content:*

- 2.1 Technical parts drawing
- 2.2 Working plan
- 2.3 Transverse facing
- 2.4 Centerboring
- 2.5 Clamping work piece between centres
- 2.6 Turning of shoulders with left turning tools, roughing
- 2.7 Turning of shoulders with right turning tools, roughing
- 2.8 Turning of snap ring groove
- 2.10 Finishing with accuracy of 0,05 mm
- 2.11 Measuring dimensions with caliper and micrometer

**Lesson 3:**

**Turning piston rod**

(8h)

*Objectives:*

After finishing this lesson, the trainees are able to;

- Read and use engineering drawings of components and sub-assemblies.
- Determine tolerances, fits and surface finish from technical drawings and observe for production.
- Operate measuring instruments for lengths (accuracy of 0.01mm), micrometer
- Select and fasten centres in the spindle and tailstock of a lathe.
- Align and hold work pieces with three jawed chucks and centres with particular attention to work piece stability and surface protection.

- Align and hold tools with chucks and tool-holders.
- Develop working plans for production of components according to given work order.
- Select and provide tools according to production method and work order, type of material (work piece and cutting material) and cutting edge geometry.
- Determine and set speed of revolution, feed and depth of cut on machine tools for turning operations with the aid of tables and diagrams.
- Prepare machine tools for operation
- Produce work pieces of ferrous and non-ferrous metals by turning up to a dimensional accuracy of  $\pm 0,05$  mm and surface finish Rz 25  $\mu\text{m}$  by transverse and longitudinal facing, longitudinal turning and form turning (chamfer, thread).
- Arrange their work place functional, safe and accessible.

*Content:*

- 3.1 Technical parts drawing
- 3.2 Working plan
- 3.3 Transverse facing to length
- 3.4 Centerboring
- 3.5 Clamping work piece between centres
- 3.6 Longitudinal turning of piston rods
- 3.7 Turning of shoulder
- 3.8 Turning of grooves and chamfers
- 3.9 Threading with die
- 2.10 Measuring dimensions with caliper and micrometer

**Lesson 4:**

**Turning piston**

(4 h)

*Objectives:*

After finishing this lesson, the trainees are able to;

- Read and use engineering drawings of components and sub-assemblies.
- Determine tolerances, fits and surface finish from technical drawings and observe for production.
- Select and operate measuring instruments for lengths (accuracy of 0.01mm)
- Align and hold work pieces with three jawed chucks with particular attention to work piece stability and surface protection.
- Align and hold tools with chucks and tool-holders.
- Develop working plans for production of components according to given work order.
- Select and provide tools according to production method and work order, type of material (work piece and cutting material) and cutting edge geometry.

- Determine and set speed of revolution, feed and depth of cut on machine tools for turning and drilling operations with the aid of tables and diagrams.
- Prepare machine tools for operation
- Produce work pieces of ferrous and non-ferrous metals by turning up to a dimensional accuracy of  $\pm 0,05$  mm and surface finish Rz 25  $\mu$ m by transverse and longitudinal facing, longitudinal turning, internal turning, transverse cut-off turning and form turning (chamfer, ring groove).
- Produce holes in work pieces with drills clamped in chucks in tailstock.
- Arrange their work place functional, safe and accessible.

*Content:*

- 4.1 Technical parts drawing
- 4.2 Working plan
- 4.3 Transverse facing to length
- 4.4 Longitudinal turning
- 4.5 Drilling
- 4.6 Cut-off turning
- 4.7 Turning of grooves and chamfers
- 4.8 Checking and measuring
- 4.9 Drilling operations

**Lesson 5:**

**Turning cylinder housing**

(8 h)

*Objectives:*

After finishing this lesson, the trainees are able to;

- Read and use engineering drawings of components and sub-assemblies.
- Determine tolerances, fits and surface finish from technical drawings and observe for production.
- Select and operate measuring instruments for lengths (accuracy of 0.01mm) and angles (accuracy up to 5').
- Check parallelism of surface and concentricity with dial gauges.
- Scribe, centre-punch and mark work pieces under consideration of properties of materials.
- Select and fasten clamping tools in accordance with size, form, working material and the machining of work pieces for drilling, milling and turning.
- Align and hold work pieces with three jawed chucks and centres with particular attention to work piece stability and surface protection.
- Align and hold tools with chucks, clamping cones, holding clamps and tool-holders.
- Develop working plans for production of components according to given work order.

- Select and provide tools according to production method and work order, type of material (work piece and cutting material) and cutting edge geometry.
- Determine and set speed of revolution, feed and depth of cut on machine tools for drilling/boring, turning and milling operations with the aid of tables and diagrams.
- Prepare machine tools for operation
- Produce work pieces of ferrous by turning up to a dimensional accuracy of  $\pm 0,05$  mm and surface finish Rz 25  $\mu\text{m}$  by transverse and longitudinal facing, longitudinal turning, internal turning.
- Produce work pieces of ferrous metals by milling up to a dimensional accuracy of  $\pm 0,05$  mm and a surface finish Rz 25  $\mu\text{m}$  by horizontal and vertical face milling and drilling.
- Arrange their work place functional, safe and accessible.

*Content:*

- 5.1 Technical parts drawing
- 5.2 Working plan
- 5.3 Transverse facing
- 5.4 Centerboring
- 5.5 Longitudinal turning
- 5.6 Clamping with steady rest
- 5.7 Drilling
- 5.8 Internal turning
- 5.9 Milling of clamping areas
- 5.10 Drilling of holes for fixing screws
- 5.11 Checking and measuring

**Lesson 6:**

**Manufacturing of mounting plate**

(6 h)

*Objectives:*

After finishing this lesson, the trainees are able to;

- Read and use engineering drawings of components and sub-assemblies.
- Determine tolerances, fits and surface finish from technical drawings and observe for production.
- Select and operate measuring instruments for lengths (accuracy of 0.01mm) and angles (accuracy up to 5').
- Check parallelism of surface and concentricity with dial gauges.
- Scribe, centre-punch and mark work pieces under consideration of properties of materials.

- Select and fasten clamping tools in accordance with size, form, working material and the machining of work pieces for drilling, milling and turning.
- Align and hold work pieces with three jawed chucks and mandrels with particular attention to work piece stability and surface protection.
- Align and hold tools with chucks, clamping cones, holding clamps and tool-holders.
- Develop working plans for production of components according to given work order.
- Select and provide tools according to production method and work order, type of material (work piece and cutting material) and cutting edge geometry.
- Determine and set speed of revolution, feed and depth of cut on machine tools for drilling/boring, turning and milling operations with the aid of tables and diagrams.
- Prepare machine tools for operation
- Produce work pieces of ferrous materials by turning up to a dimensional accuracy of  $\pm 0,05$  mm and surface finish Rz 25  $\mu$ m by transverse facing and longitudinal turning.
- Produce work pieces of ferrous metals by milling up to a dimensional accuracy of  $\pm 0,05$  mm and a surface finish Rz 25  $\mu$ m by horizontal and vertical face milling and drilling.
- Arrange their work place functional, safe and accessible.

*Content:*

- 6.1 Technical parts drawing
- 6.2 Working plan
- 6.3 Transverse facing
- 6.4 Drilling
- 6.5 Clamping with mandrel
- 6.6 Longitudinal turning
- 6.7 Milling of flat area
- 6.8 Drilling of holes for fixing screws, tapping
- 6.9 Checking and measuring

**Lesson 7:**

**Assembling of cylinder**

(4 h)

*Objectives:*

After finishing this lesson, the trainees are able to;

- Read group- and assembly drawings and component lists.
- Determine working steps for mounting assemblies.
- Select and provide tools for assembling.
- Connect components with screws and fitting connections.
- Check the function of moving parts.

- Check components for flush mounting
- Adjust components for mounting and rework
- Arrange the work place functional, safe and accessible.

*Content:*

- 7.1 Assembly drawings.
- 7.2 Components list.
- 7.3 Mounting piston and cylinder.
- 7.4 Checking of function
- 7.5 Adjust and mount cylinder at flange of horizontal guide
- 7.6 Checking of function

**Lesson 8:**

**Basic skills milling 1 – Guiding plate**

(12 h)

*Objectives:*

After finishing this lesson, the trainees are able to;

- Determine working steps for production of work pieces and assemblies according to functional, manufacturing and economical criteria.
- Describe manufacturing processes of milling and its characteristics (movements of work piece and tool, reachable accuracy).
- Read and use engineering drawings of components and sub-assemblies.
- Determine tolerances, fits and surface finish from technical drawings and observe for production.
- Select and operate measuring instruments for lengths (accuracy of 0.01mm) and angles (accuracy up to 5´).
- Check parallelism of surface and concentricity with dial gauges.
- Select and fasten clamping tools in accordance with size, form, working material and the machining of work pieces for milling.
- Align and hold work pieces with machine vices with particular attention to work piece stability and surface protection.
- Clamp milling tools with collet chucks and milling arbors.
- Develop working plans for production of components according to given work order.
- Select and provide milling tools according to production method and work order, type of material (work piece and cutting material) and cutting edge geometry.
- Determine and set speed of revolution, feed and depth of cut on machine tools for milling operations with the aid of tables and diagrams.
- Prepare machine tools for operation

- Produce work pieces of ferrous metals by milling up to a dimensional accuracy of  $\pm 0,05$  mm and a surface finish Rz 25  $\mu$ m by horizontal and vertical face milling, groove and slot milling.
- Arrange their work place functional, safe and accessible.
- Describe and follow safety regulations, particularly those arising from operation of milling machines.

*Content:*

- 8.1 Technical parts drawing
- 8.2 Working plan
- 8.3 Clamping work piece in machine vice
- 8.4 Clamping milling tools in milling arbors
- 8.5 Face milling of areas
- 8.6 Milling of shoulders
- 8.7 Drilling
- 8.8 Clamping end mills in collet chucks
- 8.9 Milling of grooves
- 8.10 Checking and measuring

**Lesson 9:**

**Basic skills milling 2 – Housing**

(12 h)

*Objectives:*

After finishing this lesson, the trainees are able to;

- Read and use engineering drawings of components and sub-assemblies.
- Determine tolerances, fits and surface finish from technical drawings and observe for production.
- Select and operate measuring instruments for lengths (accuracy of 0.01mm) and angles (accuracy up to 5').
- Check parallelism of surface and concentricity with dial gauges.
- Select and fasten clamping tools in accordance with size, form, working material and the machining of work pieces for drilling, milling and turning.
- Align and hold work pieces with machine vices with particular attention to work piece stability and surface protection.
- Clamp milling tools with collet chucks and arbors.
- Develop working plans for production of components according to given work order.
- Select and provide milling tools according to production method and work order, type of material (work piece and cutting material) and cutting edge geometry.
- Determine and set speed of revolution, feed and depth of cut on milling machines with the aid of tables and diagrams.

- Prepare milling machine for operation
- Produce work pieces of ferrous and non-ferrous metals by milling up to a dimensional accuracy of  $\pm 0,05$  mm and a surface finish Rz 25  $\mu\text{m}$  by horizontal and vertical face milling, groove and slot milling.
- Arrange their work place functional, safe and accessible.

*Content:*

- 9.1 Technical parts drawing
- 9.2 Working plan
- 9.3 Face milling of areas
- 9.4 Milling of shoulders
- 9.5 Clamping end mills in collet chucks
- 9.6 Milling of grooves
- 9.7 Milling of slots
- 9.8 Checking and measuring

**Lesson10:**

**Cutting guide block**

(8 h)

*Objectives:*

After finishing this lesson, the trainees are able to;

- Determine working steps for production of work pieces and assemblies according to functional, manufacturing and economical criteria.
- Read and use engineering drawings of components and sub-assemblies.
- Determine tolerances, fits and surface finish from technical drawings and observe for production.
- Select and operate measuring instruments for lengths (accuracy of 0.01mm) and angles (accuracy up to 5').
- Check parallelism of surface and concentricity with dial gauges.
- Describe ISO-system of fits, determine limit deviations and check dimensions with limit plug gauges and external limit gauges.
- Scribe, centre-punch and mark work pieces under consideration of properties of materials.
- Select and fasten clamping tools in accordance with size, form, working material and the machining of work pieces for drilling and milling.
- Align and hold work pieces with machine vices with particular attention to work piece stability and surface protection.
- Align and hold tools with drilling chucks, collet chucks and milling arbors.
- Develop working plans for production of components according to given work order.

- Select and provide tools according to production method and work order, type of material (work piece and cutting material) and cutting edge geometry.
- Determine and set speed of revolution, feed and depth of cut on machine tools for drilling/boring and milling operations with the aid of tables and diagrams.
- Prepare machine tools for operation
- Produce holes in work pieces up to a positional tolerance of  $\pm 0.2\text{mm}$  on drilling machines, including profile holes by countersinking and counterboring, fit holes up to a dimensional accuracy IT 7 by circular reaming and tapping
- Produce work pieces of ferrous and non-ferrous metals by milling up to a dimensional accuracy of  $\pm 0,05\text{ mm}$  and a surface finish  $Rz 25\ \mu\text{m}$  by horizontal and vertical face milling, groove and slot milling.
- Arrange their work place functional, safe and accessible.

*Content:*

- 10.1 Technical parts drawing
- 10.2 Working plan
- 10.3 Cutting of guide block
- 10.4 Milling of guide block and distance pieces
- 10.5 Scribing of center lines for drilling
- 10.6 Drilling and counterboring
- 10.7 Tapping
- 10.8 Checking and measuring

**Lesson 11:**

**Milling of guide frame**

(12 h)

*Objectives:*

After finishing this lesson, the trainees are able to;

- Determine working steps for production of work pieces and assemblies according to functional, manufacturing and economical criteria.
- Read and use engineering drawings of components and sub-assemblies.
- Determine tolerances, fits and surface finish from technical drawings and observe for production.
- Select and operate measuring instruments for lengths (accuracy of  $0.01\text{mm}$ ) and angles (accuracy up to  $5'$ ).
- Check parallelism of surface and concentricity with dial gauges.
- Describe ISO-system of fits, determine limit deviations and check dimensions with limit plug gauges and external limit gauges.
- Scribe, centre-punch and mark work pieces under consideration of properties of materials.

- Select and fasten clamping tools in accordance with size, form, working material and the machining of work pieces for drilling and milling.
- Align and hold work pieces with machine vices with particular attention to work piece stability and surface protection.
- Align and hold tools with drilling chucks, collet chucks and milling arbors.
- Develop working plans for production of components according to given work order.
- Select and provide tools according to production method and work order, type of material (work piece and cutting material) and cutting edge geometry.
- Determine and set speed of revolution, feed and depth of cut on machine tools for drilling/boring and milling operations with the aid of tables and diagrams.
- Prepare machine tools for operation
- Produce holes in work pieces up to a positional tolerance of  $\pm 0.2\text{mm}$  on drilling machines, including profile holes by countersinking and counterboring, fit holes up to a dimensional accuracy IT 7 by circular reaming and tapping
- Produce work pieces of ferrous and non-ferrous metals by milling up to a dimensional accuracy of  $\pm 0,05\text{ mm}$  and a surface finish  $Rz 25\ \mu\text{m}$  by horizontal and vertical face milling, groove and slot milling.
- Arrange their work place functional, safe and accessible.

*Content:*

- 11.1 Technical parts-and assembly drawing
- 11.2 Working plan for production of guide frame.
- 11.3 Milling vertical stands
- 11.4 Scribing centre lines for drilling
- 11.5 Clamping frame stands and distance pieces together.
- 11.6 Drilling and tapping
- 11.7 Connecting frame stands and distance pieces by screws
- 11.8 Drilling and reaming of pin holes

**Lesson 12:**

**Milling of guide carriage**

(10 h)

*Objectives:*

After finishing this lesson, the trainees are able to;

- Determine working steps for production of work pieces and assemblies according to functional, manufacturing and economical criteria.
- Read and use engineering drawings of components and sub-assemblies.
- Determine tolerances, fits and surface finish from technical drawings and observe for production.

- Select and operate measuring instruments for lengths (accuracy of 0.01mm) and angles (accuracy up to 5').
- Check parallelism of surface and concentricity with dial gauges.
- Describe ISO-system of fits, determine limit deviations and check dimensions with limit plug gauges and external limit gauges.
- Scribe, centre-punch and mark work pieces under consideration of properties of materials.
- Select and fasten clamping tools in accordance with size, form, working material and the machining of work pieces for drilling and milling.
- Align and hold work pieces with machine vices with particular attention to work piece stability and surface protection.
- Align and hold tools with drilling chucks, collet chucks and milling arbors.
- Develop working plans for production of components according to given work order.
- Select and provide tools according to production method and work order, type of material (work piece and cutting material) and cutting edge geometry.
- Determine and set speed of revolution, feed and depth of cut on machine tools for drilling/boring and milling operations with the aid of tables and diagrams.
- Prepare machine tools for operation
- Produce holes in work pieces up to a positional tolerance of  $\pm 0.2\text{mm}$  on drilling machines, including profile holes by countersinking and counterboring, fit holes up to a dimensional accuracy IT 7 by circular reaming and tapping
- Produce work pieces of ferrous and non-ferrous metals by milling up to a dimensional accuracy of  $\pm 0,05\text{ mm}$  and a surface finish  $Rz 25\ \mu\text{m}$  by horizontal and vertical face milling, groove and slot milling.
- Arrange their work place functional, safe and accessible.

*Content:*

- 12.1 Technical parts-and assembly drawing
- 12.2 Working plan for production of guide frame.
- 12.3 Milling guide carriages
- 12.4 Scribing centre lines for drilling
- 12.5 Clamping guide and guide carriages together.
- 12.6 Drilling and tapping
- 12.7 Connecting guide and guide carriages by screws
- 12.8 Drilling and reaming of pin holes

**Lesson 13:**

**Mounting of subassembly 3 – Vertical guide**

(6 h)

*Objectives:*

After finishing this lesson, the trainees are able to;

- Determine working steps for mounting assemblies.
- Read group- and assembly drawings.
- Select and provide tools for assembling.
- Connect components with screws and fitting connections.
- Check the function of moving parts.
- Check components for flush mounting
- Adjust components for mounting and rework
- Arrange their work place functional, safe and accessible.

*Content:*

13.1 Assembly drawings.

13.2 Components list.

13.3 Mounting guide frame on channel piece.

13.4 Adjust and rework components of guide carriage flush

13.5 Mounting of guide carriage in guide frame

13.6 Adjust and rework guide carriage in guide frame

13.7 Checking of function

#### **Lesson 14:**

#### **Module examination**

(10 h)

*Objectives:*

After finishing this lesson, the trainees are able to;

- Determine working steps for production of work pieces and assemblies according to functional, manufacturing and economical criteria.
- Describe manufacturing processes (turning, milling, drilling, grinding) and their characteristics (movements of work piece and tool, reachable accuracy).
- Read and use engineering drawings of components and sub-assemblies.
- Determine tolerances, fits and surface finish from technical drawings and observe for production.
- Select and operate measuring instruments for lengths (accuracy of 0.01mm) and angles (accuracy up to 5').
- Check parallelism of surface and concentricity with dial gauges.
- Describe ISO-system of fits, determine limit deviations and check dimensions with limit plug gauges and external limit gauges.
- Scribe, centre-punch and mark work pieces under consideration of properties of materials.

- Select and fasten clamping tools in accordance with size, form, working material and the machining of work pieces for drilling, milling and turning.
- Align and hold work pieces with machine vices, clamping jaws, step-blocks, three jawed chucks and centres with particular attention to work piece stability and surface protection.
- Align and hold tools with chucks, clamping cones, holding clamps and tool-holders.
- Develop working plans for production of components according to given work order.
- Select and provide tools according to production method and work order, type of material (work piece and cutting material) and cutting edge geometry.
- Determine and set speed of revolution, feed and depth of cut on machine tools for drilling/boring, turning and milling operations with the aid of tables and diagrams.
- Prepare machine tools for operation
- Produce holes in work pieces up to a positional tolerance of  $\pm 0.2\text{mm}$  on drilling machines, including profile holes by countersinking and counterboring, fit holes up to a dimensional accuracy IT 7 by circular reaming and tapping
- Produce work pieces of ferrous and non-ferrous metals by turning up to a dimensional accuracy of  $\pm 0,05\text{ mm}$  and surface finish  $Rz\ 25\ \mu\text{m}$  by transverse and longitudinal facing, longitudinal turning, internal turning, transverse cut-off turning and form turning (chamfer, radii, taper, thread).
- Produce work pieces of ferrous and non-ferrous metals by milling up to a dimensional accuracy of  $\pm 0,05\text{ mm}$  and a surface finish  $Rz\ 25\ \mu\text{m}$  by horizontal and vertical face milling, groove and slot milling.
- Join work pieces by bolted/screwed and pin connections, fits and keys.
- Arrange their work place functional, safe and accessible.
- Read components-lists, assign designations to components and select components from catalogues.
- Describe and follow safety regulations, particularly those arising from operation of drilling machines, lathes and milling machines.
- Specify environmental pollution at workplace and contribute to its reduction.

*Content:*

- 14.1 Written test
- 14.2 Assembly and parts drawings of examination device.
- 14.3 Developing working plan
- 14.4 Turning of components
- 14.5 Milling of components
- 15.6 Scribing of marking out of work pieces
- 15.7 Drilling, counterboring, reaming and tapping
- 15.8 Mounting of components to subassembly

## 15.9 Checking of function

**IV. Prerequisites for implementation of module****Machining workshop for 16 students:**

- **8 lathes, complete with**
  - Width between centers appr. 800mm
  - Tailstock
  - Three jawed chucks, centers
  - Quick change tool holders with accessories and spare parts
  - Tool set with carbide inserts and spare parts and spare inserts
  - Measuring instruments, caliper, micrometer, dial gauge
  - Machine cabinet
- **8 universal milling machines, complete with**
  - for horizontal and vertical milling
  - Power: min. 2.2kW
  - Table area: min 850 x 260mm
  - Machine vice, parallel sets, work piece clamping devices
  - Collet chucks and milling arbors
  - Tool set :shell end mills, side and face cutters, end mills, slot drills, form and profile mills (T-slot, dovetail, V-profile).
  - Measuring instruments, caliper, micrometer, dial gauge
  - Machine cabinet
- **1 set accessories for milling machines:**
  - work holding set for T-slots
  - dividing head with accessories
  - three jawed chuck for milling machines
- **2 drilling machines, complete with**
  - Pillar type or table top drilling machines
  - Diameter drilled: min 16mm
  - Table area min. 400x300mm
  - Machine vice
  - Quick change chuck and morse-tapers
  - Set of drills and spare drills
- **1 marking plates with stands**
  - 1200 x 800 mm
  - quality 3
  - marking tools
- **1 double wheel grinder with stand**
  - Grinding wheel 200x32x32
  - Grinding wheels for HSS-tools and carbides
- **1 ribbon or circular saw, complete with**

- cutting diameter: 200mm
- for mitre-cuts
- cooling system
- accessories and spare parts
- **4 working benches, complete**
  - workbench top 1500x700 x 50
  - vice, height adjustable
  - Drawer block
  - Tool set for manual production
  - Tool set for assembling
- **1 bar rack for long material**
- **2 Store-cabinets for standard parts**
  - Drawer cabinets appr. 1000x800x1000mm
  - Appr. 6 drawers
  - Inserts and sections for drawers
  - Stock of standard parts (screws, nuts washers, pins)
- **2 Store cabinets for tools**
  - Drawer cabinets appr. 1000x800x1000mm
  - Appr. 6 drawers
  - Inserts and sections for drawers
  - Special measuring instruments for instructor
  - Stock of spare tools( lathe tools, millers, drills, tappers)
- **Instructors workplace**
  - Workshop desk with drawers
  - Swivel chair
- **Classroom or teaching corner (in the workshop or directly beside the workshop)**
  - Blackboard, min. 2.5 x 1.2m
  - Overheadprojector and projection screen
  - Students chair with writing desk
- **Consumables**
  - Flat rolled steel, bright steel
  - Profile steel
  - Tools (lathe tools, milling tools,hacksaw blades, drills, tapers)
  - Cooling lubricant, cutting oil

## V. Evaluation methods and contents of tests

- The evaluation of this modules contains:

### 1. Accompanied evaluation

Every task-element (lesson) is evaluated in an evaluation form. The evaluation contains function check, visual inspection and dimension check.

## 2. Written examination

The written examination takes place at the end of the module.

The trainee solves in max. 120min questions and exercises, related to objectives and contents of this module, either in form of multiple choice questions or essay questions.

## 3. Examination work piece

The trainee shall fabricate a sub-assembly under usage of prefabricated parts in max 480min by turning, milling, drilling, manual cutting and joining.

## VI. Guide for implementation of the module

### • Fields of implementation of this module:

- This module is used to qualify the trainees of vocational training programme at 2-year intermediate level for mechatronic trade on the level of skilled worker.
- This module is a basic module, that could be also used to train:
  - mechatronic trade on college level
  - trades in the field of mechanical engineering

### • Organization:

- The lessons of this module should be organized in large blocks of at least one week up to 4 weeks duration to guarantee a steady work.

### • Some main guides in view of teaching methods for this module:

- Before implementation of this module, the teaching staff should prepare all necessary prerequisites based on contents of individual lessons to ensure the teaching quality.
- The teaching staff should guide the trainees to the ability to plan, execute and monitor their work independently.
- The teaching staff should guide the trainees to arrange their working place functional, safe and accessible.
- The teaching staff should guide the trainees to time management, this means that the trainees should finish the work pieces in a given time frame.
- The teaching staff should instruct, give examples and correct errors while the trainees practice.
- The teaching staff should especially watch the quality and accuracy of the work and the observation of tolerances.
- The teaching staff should guide the trainees to self-evaluation of their work pieces.

### • Teaching materials for module 01:

- " Qualification Project Pick & Place Device"

published by: South Westphalia Chamber of Commerce and Industry, Hagen (Germany)  
Technical Training Centers, 1993



