NATIONAL CERTIFICATES (VOCATIONAL)

SUBJECT GUIDELINES

FITTING AND TURNING

NQF LEVEL 2

IMPLEMENTATION: JANUARY 2013
INTRODUCTION

A. What is *Fitting and Turning* about?

Fitting and Turning is widely applied to engineering technology, such as in machining, maintenance and assembly situations or circumstances. It deals with the various processes involved in making or producing components required in the manufacturing, engineering and technological environment. Fitting and Turning covers land, sea, air and space technology and helps to develop and expand the global economy.

The content of this subject was revised to address gaps and shortcomings in the first version of the curriculum. The Department of Higher Education and Training worked in close collaboration with stakeholders and role players from both industry and FET Colleges who all provided valuable input and participated in the revision process.

B. Why is *Fitting and Turning* important in the Engineering Studies learning programme?

Fitting and Turning takes creativity and visionary ideology and makes it a practical reality. Through its application, Fitting and Turning expands new design technology and urges science to create new material compositions.

C. What is the link between *Fitting and Turning* Learning Outcomes and the Critical and Developmental Outcomes?

**Thinking and problem-solving skills:**
Identify and solve problems in which responses display that responsible decisions, using critical and creative thinking, have been made. Use different functions and make corrective adjustments in problematic situations.

**Independence and self-management skills:**
Organise and manage oneself and one’s activities responsibly and effectively. Plan the sequence of operations based on job instructions and adjust the equipment appropriately.

**Research skills:**
Collect, analyse, organise and critically evaluate information. Examine work piece for machining and non-conformance with specifications. Measure work piece for accuracy.

**Learning skills:**
Reflect on and explore a variety of strategies to learn more effectively. Gain experience and knowledge through application of different machining.

**Employment seeking skills:**
Explore education and career opportunities. Assure the confidence to succeed by understanding the practical application.
Entrepreneurship:
Develop entrepreneurial opportunities.
Produce a sense of self worth through confidence.

D. Which factors contribute to achieving Fitting and Turning Learning Outcomes?

- A learning environment conducive to teaching and learning through effective student support, motivation, commitment, a positive attitude and emphasis on safety
- Exposure to the mechanical engineering technology environment that will stimulate interest in the subject
- Qualified and competent lecturers who will encourage the students to develop their knowledge and skills
- Availability of appropriate workshop tools, measuring devices, machinery and equipment.
FITTING AND TURNING- LEVEL 2

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9. ANNEXURES
1. DURATION AND TUITION TIME
This is a one-year instructional programme comprising 200 teaching and learning hours. The subject may be offered on a part-time basis provided the student meets all the assessment requirements.

Students with special education needs (LSEN) must be catered for in a way that eliminates barriers to learning.

2. SUBJECT LEVEL OUTCOMES AND FOCUS
SAQA Qualification 50440
Exit Level Outcome: Identify and describe processes and methods used in Fitting and Turning.

Associated Assessment Criteria:

- Fitting and Turning processes are identified and described in accordance with industry standards.
  Range: Processes and industries include Manufacturing and Assembly, Engineering and Related Design and Fabrication and Extraction.
- Fitting and Turning methods are identified and described in accordance with industry standards.
  Range: Methods include Manufacturing and Assembly, Engineering and Related Design and Fabrication and Extraction.

3. ASSESSMENT
Information provided in this document on internal and external assessment aims to inform, assist and guide a lecturer to effectively plan the teaching of the subject. The Assessment Guidelines accompanying this document provides detailed information to plan and conduct internal and external assessments.

3.1 Internal assessment (50 percent)
Detailed information regarding internal assessment and moderation is outlined in the current Internal Continuous Assessment (ICASS) Guideline document provided by the Department of Higher Education and Training (DHET).

3.2 External assessment (50 percent)
A National examination is conducted annually in October or November by means of a paper(s) set and moderated externally. A practical component Integrated Summative Assessment Task (ISAT) will also be assessed as a component of external assessment. Detailed information regarding external assessment and moderation is outlined in the ‘National Policy on the Conduct, Administration and Management of the Assessment of the Assessment of the National Certificate Vocational’, Gazette Number 30287, dated 12 September 2007.
4.1 WEIGHTED VALUES OF TOPICS (Topic weighting and time allocation)

<table>
<thead>
<tr>
<th>Topics</th>
<th>Weight (%)</th>
<th>Duration (hrs)</th>
<th>Theory (hrs)</th>
<th>Practical (hrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Grinding and Sharpening</td>
<td>15%</td>
<td>17</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>2 Drilling Machine</td>
<td>15%</td>
<td>17</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>3 Hand Threading and Reaming</td>
<td>10%</td>
<td>11</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>4 Keys and Fasteners</td>
<td>10%</td>
<td>11</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>5 Centre Lathe</td>
<td>25%</td>
<td>27</td>
<td>11</td>
<td>16</td>
</tr>
<tr>
<td>6 Milling Machine</td>
<td>25%</td>
<td>27</td>
<td>11</td>
<td>16</td>
</tr>
</tbody>
</table>

*Teaching/contact hours (face to face) 100% 110 44 66

Hours spent on revision, homework, tests, assignments/practical, internal & external examinations and ISAT 90

Total teaching and learning hours 200

*Teaching Hours refer to the minimum hours required for face to face instruction and teaching. This number excludes time spent on revision, test series and internal and external examination/assessment. The number of the allocated teaching hours is influenced by the topic weighting, complexity of the subject content and the duration of the academic year.

3 CALCULATION OF FINAL MARK

Internal assessment mark: Student’s mark/100 x 50 = a mark out of 50 (a)

Examination mark: Student’s mark/100 x 50 = a mark out of 50 (b)

Final mark: (a) + (b) = a mark out of 100

All marks are systematically processed and accurately recorded to be available as hard copy evidence for, amongst others, reporting, and moderation and verification purposes.

4 PASS REQUIREMENTS

A student must obtain at least 50 percent in ICASS and 50 percent in the examination to achieve a pass in this subject.

5 SUBJECT AND LEARNING OUTCOMES

On completion of Fitting and Turning Level 2, the student should have covered the following topics:

Topic 1: Grinding and Sharpening
Topic 2: Drilling Machines
Topic 3: Hand Threading and Reaming
Topic 4: Keys and Fasteners
Topic 1: Grinding and Sharpening

Subject Outcome 1.1: Explain correct safety procedures and care when grinding tools and drill bits

Range:
- Safety procedures include excerpts from the Driven Machinery Regulations. Safety measures include the impact on human beings, machines, equipment, materials and the environment.
- Grinding machine safety includes the application of personal protective equipment, ring testing prior to mounting or checking, start-up procedures, protective guards, tool rest adjustment and other best practice procedures.

Learning Outcomes:
- Explain worksite health and safety practices.
- Explain good housekeeping.
- Explain the safety precautions before and after using the grinding machine.
- Explain the importance of a clean working area.
- Describe the necessity of cleaning equipment, materials and machines.
- Identify appropriate safety clothes for a grinding process and explain the importance of it.
- Identify and remove any flammable materials present which might cause an unsafe working environment.

Subject Outcome 1.2: Demonstrate an understanding of grinding processes associated with tools and drill bits

Range:
- A typical pedestal grinding machine and associated components are identified and their purpose is explained (Components may include shield, work rest, wheel guard, On/Off switch, pedestal, wheel spindle, coolant, wheel spindle, grinder specification plate).
- Types and grade of grinding wheels are identified according to abrasive type, grade, bonding material, grain size and structure.
- Factors determining selection of grinding wheels: applicable types according to material, amount of material to be grinded, wet or dry processes, applicable wheel speeds.
- Changing and mounting a grinding wheel and using appropriate terminology: inspection, ring testing, applicable wheel speeds, spindle hole sizes, compressible washers, flanges, spindle end-nut, direction of rotation, tool rest, safety guards, wheel mounting procedures.

Learning Outcomes:
The student should be able to:
- Identify a typical pedestal grinding machine and related components
- Identify different types of grinding wheels.
- Determine the rotational speed of a grinding machine (*Range: Visual observation (manufacturer’s tally-plate) and the use of a tachometer*)
- Identify the types of angles [helix (for drill bits), rakes, clearance etc.] of grinding tools and drill bits.
- Identify types of material using typical tests in the workshop.
- Explain correct sequence of activities to follow during grinding cutting tools and drill bits.
- Describe the implications of incorrect sequence of activities and operations.

**Subject Outcome 1.3: Plan and prepare for tool grinding.**

*Range:*
- Minimum grinding wheel diameter and thickness, cracks, spindle-nut, thrust and paper washer, transparent safety glass. Setting of the gap between the wheel and tool rest.
- Wheel dressing includes types of wheel dressers (Huntington-type and diamond-tipped)
- Recall advantages and disadvantages of wheel dresser types.
- Twist drill angles include land, heel, chisel edge, lip length, point, point angle, lip clearance angle, flute, rake angle.
- Cutting tool angles include clearance, rake and cutting angles (*Please note: prior learning associated with the properties of metals and the related heat treatment processes, namely hardening, tempering, quenching and temperature coloration of metal is required*); positive and negative rake angle and rake effectiveness for different materials; chip breaking techniques for lathe cutting tools (roughing and finishing tools – round-nose, left- and right-hand tools, parting, grooving external and internal threading tools).

**Learning Outcomes:**
- Demonstrate knowledge of different grades and shapes of grinding wheels.
- Establish material to be cut/drill with the tool/drill bit.
- Identify the types of angles (helix, rakes, clearance etc).
- Identify type of material a tool is made of.
- Identify different types of grinding wheels and codes of classification.
- Inspect the grinding wheels.
- Dress the grinding wheels and adjust the tool rest.
- Identify damaged or sub-standard components and equipment and take appropriate corrective action.

**Subject Outcome 1.4: Grind tools and drill bits.**

*Range:*
- Twist drill angles include land, heel, chisel edge, lip length, point, point angle, lip clearance angle, flute, rake angle.
- Cutting tool angles include clearance, rake and cutting angles (*Please note: prior learning associated with the properties of metals and the related heat treatment processes, namely hardening, tempering, quenching and temperature coloration of metal is required*); positive and negative rake angle and rake effectiveness for different materials; chip breaking techniques for lathe cutting tools (roughing and finishing tools – round-nose, left- and right-hand tools, parting, grooving external and internal threading tools).
grooving external and internal threading tools.

- Emphasis on the appropriate lip angle according to the type and thickness of material (stainless, mild steel, aluminium, thin sheet metal)

Please note: prior learning associated with the properties of metals and the related heat treatment processes, namely hardening, tempering, quenching and temperature coloration of metal is required. This information is worth repeating to students. The application of an appropriate drill-point gauge is required for drill sharpening exercises.

**Learning Outcomes:**

- Inspect and assess drill bits and tool condition.
- Sharpen the drill bit/tool to manufacturer’s specifications and to meet job requirements.
- Determine and complete set up angles using the correct measuring instrument.
- Position the drill bit on the rest.
- Sharpen the drill bit to meet the required angle for different materials.
- Check tool and/drill bits for compliance with specifications and apply further grinding if necessary
- Apply cooling during grinding process to prevent overheating of grinding surface.
- Apply appropriate safety practices during the grinding process.

**Subject Outcome 1.5: Store equipment and record information on completed work**

**Learning Outcomes:**

- Clean grinding tools and equipment.
- Store grinding tools and equipment in a safe place.
- Accurately record information on completed job.
- Store information in a safe place.
- Explain incidents and problems related to tool grinding.

**Topic 2 Drilling Machines**

**SubjectOutcome2.1 : Work safely with drilling machines**

**Range:**

- Safety procedures include excerpts from the Driven Machinery Regulations. Safety measures include the impact on human beings, machines, equipment, materials and the environment.
- Drilling machine safety includes the application of personal protective equipment, typical drilling hazards, safety during start-up and rotational speed setting procedures (RPM), protective guards and the elimination of shavings, electrical isolation and other best practice preventative measures.

**Learning Outcomes:**

The student should be able to:
- Recall and apply worksite health and safety practices.
- Apply good housekeeping.
• Clean work area after the completion of the task.
• Clean equipment, materials and machines after use.

**Subject Outcome 2.2: Demonstrate an understanding of drilling machines and drilling processes.**

**Range:**
- Includes the three classifications of drilling machines: Sensitive (Pedestal- and Pillar-type); Radial; portable hand-drilling machines.
- Work-holding includes: factors determining the application of work-holding types, different clamping devices (application of machine vice, angle plate, v-blocks, alternate techniques example: U-clamp; off-set clamp; finger clamp.
- Drilling of thin plate or sheet metal and effective drilling methods.
- Drilling processes include countersinking, counter-boring and spot-facing.
- Determine the rotational speed by applying the formula $s = \pi \times D \times N$
- Properties and application of cutting fluids/coolant.

**Learning Outcomes:**
The student should be able to:
- Identify and explain the functions of different types of drilling machines.
- Determine the rotational speed of a drilling machine for the drilling of specific material-types and hole sizes.
- Identify and explain the range of different clamping methods associated with drilling machines.
- Explain correct sequence of activities to follow during drilling.
- Describe the implications of incorrect sequence of activities and operations.

**Subject Outcome 2.3: Prepare for work activity and set the drilling machine**

**Learning Outcomes:**
The student should be able to:
- Select correct tools and equipment for the job.
- Choose materials for the job and calculate revolutions per minute (RPM).
- Indicate time to be taken for the job.
- Fit selected tooling to drill spindle.
- Calculate required speed and adjust machine speed.
- Clamp work piece in position relative to drill centre line axis.

**Subject Outcome 2.4: Perform drilling operations.**

**Learning Outcomes:**
The student should be able to:
- Start drilling machine.
- Monitor drilling machine.
- Adjust speeds and feeds.

**Subject Outcome 2.5: Apply quality checks and record information on completed work.**
Learning Outcomes:
The student should be able to:
• Select correct measuring tools, gauges and equipment for quality checking the component.
• Identify critical points for checking
• Recognise and report malfunctions.
• Select a name for the file and record the information on work done in the file.
• Save the file for reference purposes.

7.2 Topic 3: Hand Threading and Reaming

SubjectOutcome3.1: Work safely during threading and reaming work.

Range:
• Safety procedures include excerpts from the Driven Machinery Regulations. Safety measures include the impact on human beings, machines, equipment, materials and the environment.
• Tapping, drilling and reaming safety includes the application of personal protective equipment, typical tapping, drilling and reaming hazards and other best practice preventative measures.

Learning Outcomes:
The student should be able to:
• Explain and apply worksite health, safety and environmental protective practices.
• Apply good housekeeping.
• Recall best practice safety measures for threading and reaming.
• Demonstrate awareness of the need to keep equipment, materials and machines clean after use.
• Wear personal protective equipment during threading and reaming procedures.

Subject Outcome 3.2: Demonstrate an understanding of screw-threads.

Range:
• Screw thread terminology includes nominal or crest diameter, root or inside diameter, pitch or effective diameter, thread pitch, lead, flank, included angle, helix angle, depth of thread and related calculations \( d=0.757p \), external thread, internal thread, single-start/multi-start screw threads, right- and left-hand threads
• The various types of thread include V-thread (coarse and fine); working threads (square-, Acme-; buttress threads)

Learning Outcomes:
The student should be able to:
• Demonstrate knowledge of thread terms
• Recall the various types of thread and their applications
• Explain the different conditions by which certain types are used.

Subject Outcome 3.3: Demonstrate an understanding of hand taps, stocks and dies and
reamers.

Range:

- Terminology of hand taps includes body, shank, cutting edge, lead and flutes; Stock and dies – handles, die stock, split die, screws, locking screws, adjusting screws; Reamers – body, shank, blind centre hole, cutting edge, flutes, cutting blades.

- Types of taps include primary (taper), intermediate and plug taps; various types of tap wrenches (chuck, bar-types). Stocks and dies – circular-type (solid and split), rectangular-type (includes 2-piece rectangular dies), Solid types (hexagonal body); Reamers – parallel hand reamer, taper reamer, expanding reamer, adjustable reamer; hand and machine reamers and their applications.

- Methods of using taps include determining the tapping drill-size, method of application, testing the tap for square-ness. Application of stocks and dies must be explained.

- Common faults include drilled hole too small, tap not square in hole, tap, stock and die or reamer is used incorrectly, insufficient or incorrect lubricant. Preventative measures must also be explained or demonstrated.

- Cutting fluids apply to tapping and reaming and include their use with alloys (brass and bronze), cast-iron, stainless steels or carbon steels. Cutting fluids include lard, soluble oil, paraffin, other synthetic and progressive cutting fluid types.

Learning Outcomes:

The student should be able to:

- Demonstrate knowledge of the terminology associated with hand taps, stocks and dies and reamers.
- Recall the various types of hand taps, stocks and dies and reamers.
- Explain the different conditions by which certain types of hand taps, stocks and dies and reamers are used.
- Recall common faults associated with the use of hand tap, stocks and dies and reamers.
- Explain the function and application of various cutting fluids.

Subject Outcome 3.4: Plan and prepare materials and equipment for threading and reaming.

Range:

- Interpretation of the drawing includes the location of drilling co-ordinates.
- Cleaning of the material surface is important.
- The correct drill size or outside diameter specifications are critical.
- Selection of the taps and the preparation of the tapping or reaming sequence must be explained and demonstrated.
- Cutting fluid is appropriate for the material being threaded or reamed.
- Clamping and/or fixing methods include the use of a bench vice or appropriate fixture.

Learning Outcomes:

The student should be able to:

- Interpret the drawing and work instruction for the job.
- Select and mark off the material for the job.
- Identify the correct drill size (where applicable) for the job.
• Select the correct taps, stocks and dies and reamers.
• Prepare the correct cutting fluid
• Adjust the drilling machine to the appropriate speed (RPM) requirements.
• Apply the correct and safe clamping or fixing method for the work piece

Subject Outcome 3.5: Produce threads and ream a work-piece.

Range:
• Methods of using taps include determining the tapping drill-size, method of application, testing the tap for square-ness. Application of stocks and dies must be explained
• Hand reaming includes the application of an Expansion Hand Reamer; Adjustable Hand Reamer and a Taper Reamer
• Common faults include drilled hole too small, tap not square in hole, tap, stock and die or reamer is used incorrectly, insufficient or incorrect lubricant. Preventative measures must also be explained or demonstrated
• Cutting fluids apply to tapping and reaming and include their use with alloys (brass and bronze), cast-iron, stainless steels or carbon steels. Cutting fluids include lard, soluble oil, paraffin, other synthetic and progressive cutting fluid types.

Learning Outcomes:
The student should be able to:
• Inspect the marking position.
• Drill the work-piece and/or prepare the outside diameter for threading by chamfering the work-piece
• Apply the correct methods of threading and reaming and use the equipment correctly
• Apply the correct cutting fluid or lubricant for the job
• Conduct finishing techniques by cleaning and de-burring the work-piece

Subject Outcome 3.6: Apply quality checks and store equipment.

Learning Outcomes:
The student should be able to:
• Select gauge equipment and tools for quality checking.
• Identify critical points to be checked.
• Write a report.
• Clean threading and reaming equipment
• Store equipment in a safe place.
• Place equipment in a toolbox and/or return to store-room
• Apply lubricating oil sparingly to equipment for preservation

7.3 Topic 4: Keys and Fasteners

Subject Outcome 4.1: Work safely with keys and fasteners.

Range:
• Safety procedures include excerpts from the Driven Machinery Regulations. Safety measures include the impact on human beings, machines, equipment, materials and the environment.
• Workshop safety includes the application of personal protective equipment, typical fitting hazards and other best practice preventative measures.

Learning Outcomes:
The student should be able to:
• Explain and apply worksite health, safety and environmental protective practices.
• Apply good housekeeping.
• Recall best practice safety measures for the application of keys and fasteners.
• Demonstrate awareness of the need to keep equipment, materials and machines clean after use.
• Wear personal protective equipment during the use of keys and fasteners.

Subject Outcome 4.2: Demonstrate and understanding and application of keys and key-ways.
Range:
• Terminology of keys and keyways includes gears, pulleys, couplings; twisting torque, crushing and shearing stresses; shaft, hub, boss; spigot, recess; depth, thickness.
• The various types of keys rectangular (square, rounded, parallel), taper, taper gib-head, feather, woodruff.
• Key calculations \( t = \frac{D}{6}; \ w = \frac{D}{4} \)
• Common processes include machining processes (milling, slotting and key-seating) and broaching

Learning Outcomes:
The student should be able to:
• Demonstrate knowledge of terms associated with keys and key-ways
• Recall the various types of keys and their applications
• Explain the different conditions by which certain types of keys are used.
• Determine the main specifications (sizes) of a key or key-way
• Recall the common processes by which key-ways are produced.
• Apply the use of keys and key-ways

Subject Outcome 4.3: Demonstrate an understanding and application of fasteners.
Range:
• Terminology of fasteners includes screws (self-threading and machine); bolts, nuts and relevant terms e.g. shoulder, shank, methods of sizing, step, hexagonal head, dome-head, pan-head, round-head, cheese-head, countersunk, etc.
• Types of fasteners and their applications include Screws (thread-cutting, self-tapping, machine, cap-screws, allen-key, grub-screws, hex-socket screw); Bolts (Black bolts, machine bolts); Nuts (Positive lock-nuts – Castle-, Lock- / Friction lock-nuts – Simmonds, Nylock).
• Types of auxiliary fasteners and applications include split pins; washers; hollow tension pins; washers (spring-, star-, tab-); lock-wire; locking fluid

Learning Outcomes:
The student should be able to:
• Demonstrate knowledge of the terminology associated with fasteners
• Recall the various types of fasteners.
• Explain the different conditions by which certain types of fasteners are used.
• Demonstrate knowledge of auxiliary fasteners and their applications
• Recall common faults associated with the use of fasteners.
• Apply the use of fasteners

7.5 Topic 5: Centre Lathe

Subject Outcome 5.1: Follow safety rules and maintain safety precautions
Learning Outcomes:
The student should be able to:
• Wear and use appropriate clothing
• Check that the machine guards are in place
• Check that the work area is free and spacious
• Ensure the lathe machine is off when loading and unloading a work piece.
• Use a guard or shield to deflect chips.
• Clean the work area

Range:
Special attention to removal of chips – never touches or move chips with hands!

Subject Outcome 5.2: Prepare operation sheet
Learning Outcomes:
The student should be able to:
• Identify the type of HSS cutting tool to be used.
• Identify the work-piece material.
• Determine the work-piece diameter
• Identify the cutting speed as per the specifications
• Calculate the RPM according to roughing/finishing
• Calculate the depth of cut according to roughing/finishing
• Calculate the feed rate cut according to roughing/finishing
• Identify the proper machining sequence
• Specify an appropriate tolerance as per the drawing (e.g. ± 0.2)

Range:
• The student should be able to identify lathe components (example: headstock, tailstock, lead-screw, tool-post, tool-holder, quick-change gearbox, auto-feed lever, screw-feed lever, apron, lathe-bed, etc.)
• The operation sheet must give guidance for detailed machining step by step
• The prober sequencing to be given in pre made operation sheet
Focus points are the proper machining sequence, correct feed and speed.
The machining tolerance to achieve is ± 0.2
HSS cutting tools being used

Subject Outcome 5.3: Prepare for work activity.
Learning Outcomes:
The student should be able to:
- Select tools and equipment required for lathe operation.
- Check tools and equipment are in good working condition
- Check the lathe is maintained, oiled and lubricated.
- Demonstrate knowledge of the handles, gearbox and spindles settings
- Check that coolant is available, tested and running correctly
Range:
- The coolant used is normally an oil/water solution (3-4% oil) and must be oxidized in order to prevent fermentation and bacterial development in the fluid
- The quantity of coolant must be sufficient and never stop running during machining

Subject Outcome 5.4: Set lathe.
Learning Outcomes:
The student should be able to:
- Fit selected cutter in tool post and adjust cutter height.
- Set the graduated sleeve of the cross-slide to zero.
- Set the compound slide graduated dial to zero.
- Position carriage for cut.
- Mount the work piece in a three or four-jaw chuck.
- Clamp securely and check the set-up.
Range:
Setting of the lathe is confined to the use of a 3-jaw chuck
When setting the cutting tool always do trials cut to ensure correct height

Subject Outcome 5.5: Perform turning operations.
Learning Outcomes:
The student should be able to:
- Monitor lathe during operation
- Adjusting speeds and feeds where required.
- Set cutter against work piece and adjust cutting depth.
- Engage automatic or manual feed.
- Perform facing, longitudinal turning, grooving and Knurling
- Monitor and measure the work piece during operation
- Maintain specified tolerances
- Clean the lathe after operation
Range:
- The exercises must emphasize basic use of lathe
- To follow the operation sheet and instructions completely

Department of Higher Education and Training
The competence of achieving measurements as described in operation sheet/drawing
To rely completely on the scales
To take measurements during the machining and according use the scales
The use of HSS cutting tools which have been grinded according to specifications of materials

Subject Outcome 5.6: Apply quality checks on machined component.
Learning Outcomes:
The student should be able to:
• Select correct tools and equipment for quality checking.
• Identify values for checking and carry out measurements
• Check finish of the cut surface.

Subject Outcome 5.7: Recognise and report problems, changes and/or malfunctions while operating.
Learning Outcome:
The student should be able to
• Recognise and report problems.
• Recognise and report changes.
• Recognise and report malfunctions.

7.6
7.7 Topic 6: Milling Machine

Subject Outcome6.1: Follow safety rules and maintain safety precautions
Learning Outcomes:
The student should be able to:
• Ensure the clothing is appropriate
• Ensure the machine guards are in place
• Ensure the work area is free and spacious
• Ensure the milling machine is off when loading and unloading a work piece, when taking measurements and when cleaning
• When mounting milling cutters use gloves/hand protection
• Use a guard or shield to deflect chips
• Ensure the work area is clean and free of chips, spills and fluids

Subject Outcome6.2: Prepare operation sheet
Learning Outcomes:
The student should be able to:
• Identify the type of HSS cutting tool to be used.
• Identify the cutting speed as per the specifications
• Calculate the RPM according to roughing/finishing
• Calculate the depth of cut according to roughing/finishing
• Calculate the feed rate cut according to roughing/finishing
• Identify the proper machining sequence
• Specify an appropriate tolerance as per the drawing ± 0.2

**Range:**

- **Types of milling cutter/s include end-mill, slot-mill, circular-, rose-, side and face-, cutters and related fittings (sleeves, chucks, attachments)**
- **The operation sheet must give guidance for detailed machining step by step**
- **The prober sequencing to be given in operation sheet**
- **Focus points are the prober machining sequence, correct feed and speed.**
- **The machining tolerance to achieve is ± 0.2**
- **HSS cutting tools being used entirely.**

**Subject Outcome 6.3: Prepare for work activity.**

**Learning Outcomes:**

The student should be able to:

- Prepare the machine for operation including lubrication, routine maintenance and pre-operational checks.
- Ensure that the material and tools required are available and appropriate
- Ensure that the cutting fluid is available

**Range:**

- **The student should demonstrate the ability to identify points of lubrication and maintenance and also perform routine lubrication procedures.**
- **The coolant used is normally an oil/water solution (3-4% oil) and must be oxidized in order to prevent fermentation and bacterial development in the fluid**
- **The quantity of coolant must be sufficient and never stop running during machining**

**Subject Outcome 6.4: Set milling machine**

**Learning Outcomes:**

The student should be able to:

- Mount the appropriate cutting tool
- Select and mount machine vice
- Check that the spindle axes is perpendicular to the machining table
- Ensure that the fixed jaw of the vice is parallel and straight
- Mount and position the work piece correctly.
- Select and set cutting speeds and feeds according to operation sheet

**Range:**

- **When setting spindle axis perpendicular to machining table use dial gauge**
- **When setting the machine vice clamp use dial gauge for checking**
- **When setting and mounting work piece in machine vice use parallel strips**

**Subject Outcome 6.5: Perform milling operations.**

**Learning Outcomes:**

The student should be able to:

- Position cutter and set cutting depth and width.
• Set graduated dials to zero.
• Monitor milling machine while in operation
• Monitor and measure the work piece during operation
• Adjust the depth of cut, speeds and feeds.
• Lubricate the cutter with coolant
• Use automatic or manual feed.
• Flat and slot milling within a tolerance of ± 0.2 (with the use of an end-mill cutter).
• Cleaned the milling machine after the operation

Range:
• Special attention to ensure no hands are close to cutting tool and work piece during operation
• The first exercises must emphasize basic use of milling machine facing and slotting
• To follow the developed operation sheet and instructions completely
• The competence of achieving measurements as described in operation sheet /drawing
• To rely completely on the scales
• To take measurements during the machining and according adjust the scales

Subject Outcome 6.6: Apply quality checks on machined component.
Learning Outcomes:
The student should be able to:
• Select correct tools and equipment for quality checking.
• Identify values for checking.
• Check the cutting surface finish.
• Perform a quality check on the work piece to ensure that the machined component conforms to the specifications on the assessment sheet and drawing.

Subject Outcome 6.7: Recognise and report problems, changes and/or malfunctions while operating.
Learning Outcomes:
The student should be able to:
• Recognise and report problems.
• Recognise and report changes.
• Recognise malfunctions.

8. RESOURCE NEEDS FOR THE TEACHING OF FITTING AND TURNING– LEVEL 2

8.1 Physical resources
• Classroom/Lecture room equipped with teaching aids
• Suitably equipped workshop for fitting and machining (See Annexure A)
• Store room for consumables, attachments and fixtures, portable power tools and related equipment (See Annexure B)
• Pre-designed models
8.2 Human resources

It is recommended that a lecturer in *Fitting and Turning– Level 2 must be*

- A subject matter expert (artisan qualification)
- In possession of an appropriate teaching qualification (Recommended)
- Competent in facilitation and group learning methodologies
- Familiar with OBE methodologies
- Knowledgeable in learning and assessment requirements of the FET-college requirements for this learning program (prior to commencement)

It is of paramount importance that facilitator/lecturers attend seminars and upgrading workshops in order to be updated and re-skilled with the latest developments in the technologies related to Fitting and Machining.

8.3 Other resources

Funds to procure consumables and equipment.

9.1 Learning and Teaching materials

Textbook approved by the Department of Higher Education and Training and the latest Legislation, Regulations and National Standards (SANS) associated with Occupational Health and Safety.

9. Annexure:

9.1 Assessment sheet for turning exercises
9.2 Machining procedure - description
9.3 Fitter – physical resources
9.4 Machinist – physical resources
Annexure 9.1: A typical assessment sheet for turning projects (Exemplar)

<table>
<thead>
<tr>
<th>Description</th>
<th>Dimension</th>
<th>Tolerance</th>
<th>Assessment:</th>
<th>Dimensions measured by Participant</th>
<th>Dimensions measured by Inspector</th>
<th>Points:</th>
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Total no. Of point out of points: |
## Annexure 9.2: Operation description Task 4 (Exemplar)

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<th>Fn</th>
<th>n</th>
<th>Ap</th>
<th>D</th>
<th>L</th>
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**Sketch of work piece:**

![Sketch of work piece](image-url)
Annexure 9.3: Physical Resources for Fitting

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<td>SECTION B: MARKING / MEASURING EQUIPMENT</td>
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<tr>
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<td>Vernier height gauge</td>
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<td>Gear-drive training station</td>
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<td>21</td>
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ANNEXURE 9.4: Physical Resources – Machining (Turner)

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<th>TURNER EQUIPMENT AND TOOL LIST X 10 LEARNERS</th>
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**TOOLS, EQUIPMENT AND MACHINERY PRICING SHEET**

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<td>Vernier height gauge</td>
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<tr>
<td><strong>H</strong></td>
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<td>41</td>
<td>Safety Boots</td>
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<td>42</td>
<td>Ear plug/protection</td>
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<tr>
<td>43</td>
<td>Safety goggles</td>
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<tr>
<td>44</td>
<td>Hard hat</td>
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