NATIONAL CERTIFICATES (VOCATIONAL)

SUBJECT GUIDELINES

FITTING AND TURNING

NCV LEVEL 3

IMPLEMENTATION: JANUARY 2014
INTRODUCTION

A. What is Fitting and Turning about?

Fitting and Turning is practiced by individuals in a trade-related occupation (career artisans) and within the broader sub-field of Manufacturing, Engineering and Related Technology. Individuals in this occupation need to apply a wide range of mechanical technology and skills in machining, installation, maintenance, repair, overhaul and assembly of machinery and associated equipment and mechanical sub-systems. Fitter and Turners, as they are called, are utilised in the Manufacturing, Mining, Transport, Food, Chemical, Petro-chemical and Electrical Power industries. They help to develop and expand the national and global economy.

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

Fitting and Turning brings the range of mechanical technologies to the practical reality of maintenance and repair of machines and associated equipment and mechanical sub-systems. Through application, Fitting and Machining expands from its traditional skills base into new mechanical technologies derived through practice of the mechanical engineering discipline.

C. 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 sequences of operations based on job instructions and adjust equipment appropriately.

Research skills:
Collect, analyse, organise and critically evaluate information.
Examine work pieces for machining quality and non-conformance with specifications.
Measure work pieces 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 methods and processes.

Employment seeking skills:
Explore education and career opportunities.
Gain the confidence to succeed by understanding practical applications.

Entrepreneurship:
Develop entrepreneurial opportunities.
Produce a sense of self worth through confidence.

D. Factors that 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 students to develop their knowledge and skills
- Availability of appropriate workshop tools, measuring devices, machinery and equipment.
FITTING AND TURNING - LEVEL 3

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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 50442**

- Recognise and explain the function, purpose and/or working principles of different fitting and turning machine components.
- Maintain (inspect, dis-assemble and assemble) different fitting and turning machine components using appropriate tools and equipment applying correct safety procedures and care.
  
  *Range: Bearings, couplings, brakes and clutches, belt drives, chain drives, gear drives, pipes and pipe fittings, valves, centre lathe, milling machine.*

**Associated Assessment Criteria:**

- Correct safety procedures and care are explained and performed when maintaining fitting and turning machine components.
- Different fitting and turning machine components are identified and their purpose, functions and working principles are explained.
- Different fitting and turning machine components are maintained (inspected, assembled and re-assembled) according to manufacturer's specifications.
- Machinery, equipment and tools are maintained according to manufacturer's specifications.

3. **ASSESSMENT**

Information provided in this document on internal and external assessment aims to inform, assist and guide lecturers to plan the effective teaching of the subject.

The *Assessment Guidelines* accompanying this document provide detailed information for planning and conducting 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, the Integrated Summative Assessment Task (ISAT), will be included in the external assessment.

4. WEIGHTED VALUES OF TOPICS (Topic weighting and time allocation)

<table>
<thead>
<tr>
<th>Topic</th>
<th>Weight %</th>
<th>Duration (hrs)</th>
<th>Theory (hrs)</th>
<th>Practical (hrs)</th>
</tr>
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<tbody>
<tr>
<td>1 Bearings</td>
<td>12%</td>
<td>13</td>
<td>5</td>
<td>8</td>
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<tr>
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<td>10%</td>
<td>11</td>
<td>4</td>
<td>7</td>
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<tr>
<td>3 Brakes and Clutches</td>
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<td>3</td>
<td>6</td>
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<tr>
<td>4 Belt drives</td>
<td>7%</td>
<td>9</td>
<td>3</td>
<td>6</td>
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<tr>
<td>5 Chain drives</td>
<td>8%</td>
<td>9</td>
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<td>6</td>
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<td>6 Gear drives</td>
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<td>5%</td>
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<td>9 Centre Lathe</td>
<td>20%</td>
<td>22</td>
<td>8</td>
<td>14</td>
</tr>
<tr>
<td>10 Milling Machine</td>
<td>20%</td>
<td>22</td>
<td>8</td>
<td>14</td>
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</tbody>
</table>

Total 100% 110 40 70

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

5. 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, among others, reporting, moderation and verification purposes.

6. 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.

7. SUBJECT AND LEARNING OUTCOMES

On completion of *Fitting and Turning Level 3*, the student should have covered the following topics:

- Topic 1: Bearings
- Topic 2: Couplings
- Topic 3: Brakes and Clutches
- Topic 4: Belt Drives
Topic 1: Bearings

Subject Outcome 1.1: Explain correct safety procedures and care when maintaining bearings in machines and equipment

Range:
- Safety procedures include excerpts from the Driven Machinery Regulations. Safety measures include the impact on human beings, machines, equipment, materials and the environment.
- Bearing safety includes the application of personal protective equipment, assembly, dismantling start-up procedures, protective guards and other best practice procedures.

Learning Outcomes:
The student should be able to:
- Explain worksite health and safety practices.
- Explain the importance of a clean working area.
- Explain good housekeeping.
- Explain the safety precautions before and after replacing bearings.
- Explain why it is necessary to use correct tools, equipment and cleaning materials.
- Identify appropriate safety clothing and explain its importance.

Subject Outcome 1.2: Demonstrate an understanding of plain and anti-friction bearings.

Range:
- Types of plain (sliding) bearings include pedestal bearing; plain split bearing; plumber-block bearing; taper bearing; hanger bearing; single and multi-collar thrust bearings; footstep bearing; Mitchell thrust bearing and machine Slides
- Includes the ability to differentiate between solid and split bearings and bushes
- Includes radial, thrust and combined loads.
- The properties include embeddability, load capacity, thermal conductivity, cost, fatigue strength, corrosion resistance, compatibility, conformability.
- Plain bearing materials include cast-iron, bronze, white metal, nylon and tufnol.
- Rolling bearings include single and double row radial ball bearing, single and double row radial cylindrical roller bearings, thrust ball and roller bearings (single and double row), single row angular contact ball bearing, spherical (barrel) roller bearing, tapered roller bearing, self-aligning bearing (ball and roller), needle roller bearings.
- Different types of bearing seals include shields and seals which are removable and non-removable, rubber-types, metal, stainless steel, and synthetic material-types, and pre-packed types.
- Main components of anti-friction bearings include all components.

Learning Outcomes:
The student should be able to:
- Explain the functions of bearings
- Identify the types of plain (sliding) bearings.
- State the advantages and disadvantages of plain (sliding) bearings.
- Categorise plain bearings according to load carrying ability.
- Describe the properties and applications for plain bearing materials.
- Identify the following rolling bearings from a given drawing and name them.
- State the advantages and disadvantages of anti-friction bearings.
- Discuss the different types of bearing seals.
- Identify and name the main components of anti-friction bearings.

**Subject Outcome 1.3: Plan and prepare for bearing replacement.**

**Learning Outcomes:**

The student should be able to:
- Obtain documents and investigate bearing history.
- Interpret engineering drawings.
- Determine maintenance schedule.
- Identify type of bearing.
- Identify appropriate tools and equipment for the job.
- Explain bearing replacement to be completed.

**Subject Outcome 1.4: Prepare site and equipment for bearing replacement.**

**Learning Outcomes:**

The student should be able to:
- Isolate equipment electrically from other energy sources.
- Isolate equipment mechanically from other energy sources.
- Select appropriate tools and equipment.

**Subject Outcome 1.5: Check bearings.**

**Learning Outcomes:**

The student should be able to:
- Inspect bearing assemblies for conformance to manufacturer’s specifications.
- Check bearing lubrication.
- Check bearing cooling devices.
- Bearing conditions established using diagnostic equipment.

**Subject Outcome 1.6: Maintain, remove, inspect and install bearings.**

**Range:**

- *Description of the main parts, practical uses, mounting procedures, adjustment and operation of all plain bearings.*
- *The maintenance of plain bearings includes: causes of bearing failure and overheating; procedures for taking up wear.*
- *Maintenance on plain (sliding) bearings may include work on a pedestal bearing; plain split bearing; plumber-block bearing; taper bearing; hanger bearing; single and multi-collar thrust bearings; footstep bearing; Mitchell thrust bearing and machine slides.*
• Maintenance on rolling or anti-friction bearings includes work on single and double row radial ball bearing, single and double row radial cylindrical roller bearing, thrust ball and roller bearing (single and double row), single row angular contact ball bearing, spherical (barrel) roller bearing, tapered roller bearing, self-aligning bearing (ball and roller), needle roller bearings.
• Maintenance/removal/installation of anti-friction bearings includes fitting, mounting, describing bearing failures and cleaning procedures.
• Removal includes use of screw puller, impact puller, hydraulic puller and puller plates, use of hydraulic press or hammer.
• Mounting/installation – onto shaft/housing – heating methods (oil bath, heating lamps, induction heater) and use of hydraulic press or hammer and punch/sleeve.
• Inspection of bearings includes inspection of bearing assemblies for conformance to specifications, bearing lubrication checks, bearing cooling checks and the application of diagnostic equipment for condition monitoring.
• Pre-load methods include deadweight, spring and solid clamping and handling conditions related to safety of self and efficiency of bearing.

Learning Outcomes:
The student should be able to:
• Remove bearings and/or assemblies.
• Identify the bearing parts.
• Strip bearing assemblies.
• Clean bearings and associated parts.
• Inspect for damage and wear.
• Select bearing parts to replace.
• Select fitting equipment.
• Install bearing assemblies in accordance with manufacturer’s specifications.
• Secure locking devices in accordance with machine requirements.
• Explain and perform correct sequence of activities to follow when maintaining bearings
• Describe possible incorrect decisions that can be taken during the maintaining of bearings.
• Explain the implications of incorrect sequencing of activities and operations.

Subject Outcome 1.7: Conduct quality checks after installation and record information.
Learning Outcomes:
The student should be able to:
• Check replacement parts.
• Test replacement parts.
• Apply appropriate safety practices during the quality checking process.
• Open a new file and name it or use an existing file.
• Accurately record information on the completed job.
• Store information in a safe place.

Topic 2: Couplings

Subject Outcome 2.1: Work safely with couplings
Range:
• Safety procedures include excerpts from the Driven Machinery Regulations. Safety measures
include the impact on human beings, machines, equipment, materials and the environment.

- Coupling/machine safety includes the application of personal protective equipment, assembly, dismantling start-up procedures, protective guards and other best practice procedures.

**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 working with couplings.
- Demonstrate awareness of the need to keep equipment, materials and machines clean after use.
- Wear personal protective equipment during the maintenance and overhaul of couplings.

**Subject Outcome 2.2: Demonstrate an understanding of couplings.**

**Range:**

Guidelines for demonstrating and understanding of couplings include:

- Explanation of the difference in operation between a coupling and a clutch.
- Classification of the different types of couplings into THREE main groups, namely rigid/permanent; flexible and self-aligning types.
- A description (with the aid of given drawings) of the different types of couplings should be included for fixed/permanent types (flange, marine, chain, gear, Oldham fluid types); flexible types (Raffard, pin- and rubber-bush, rubber belt, Bibby, tyre coupling (fenner-flex), spider, nylon sleeve, metal disc); self-aligning types (universal or Hooke’s coupling, CV-joint). A description should also include an explanation of the application and construction of each type, with examples.
- Identification of sub-components of each coupling type may be asked of the student.
- A brief description of the assembly and alignment of couplings. Note that types of misalignment may be described (angular, radial, axial). This should include a brief description of the various alignment techniques (simple, double-clock and laser alignment).

**Learning Outcomes:**

The student should be able to:

- List the working principle/s, function and application of couplings.
- Use correct terminology associated with couplings.
- List the various types and applications of couplings.
- Explain the different conditions under which certain types of couplings are used in engineering systems.
- Describe the different types of misalignment and explain techniques for achieving coupling alignment after re-assembly to the machine or engineering system.
- List common faults and remedies associated with the use of couplings on machines.

**Subject Outcome 2.3: Plan and prepare materials and equipment for the dismantling and repair of couplings.**

**Learning Outcomes:**

The student should be able to:

- Interpret drawings and work instructions for the job
- Select components and consumables for the job.
- Identify the correct coupling and/or clutch or associated components (where applicable) for the
job.

- Read and understand typical manufacturers’ specification sheets and/or prescribed guidelines.
- Apply correct and safe methods for the maintenance, repair and overhaul of couplings.

**Subject Outcome 2.4: Dismantle, assemble and align couplings**

**Range:**
- *This task may be simulated with a typical workshop coupling station.*
- *A typical flange-type coupling may be used for this purpose although a Bibby or similar-type may be used.*
- *Alignment method should be basic with the aid of an engineering square, feather gauge and feelers (clock gauge is optional)*

**Learning Outcomes:**

The student should be able to:
- Remove the coupling from the machine.
- Inspect the coupling on-site or in the repair workshop.
- Dismantle the coupling according to the prescribed method.
- Inspect the components for wear and evaluate the condition.
- Lubricate and re-assemble the coupling according to the prescribed method.
- Refit and align the coupling to the machine or engineering system.
- Conduct finishing processes in preparation for quality inspection.

**Subject Outcome 2.5: Apply quality checks and store equipment.**

**Learning Outcomes:**

The student should be able to:
- Identify factors associated with the quality checking of completed assembly work for couplings.
- Write a report.
- Clean tools and equipment.
- Apply lubricating oil sparingly to equipment for preservation.
- Store and place equipment in a toolbox and/or return to store-room.

**Topic 3: Brakes and Clutches**

**Subject Outcome 3.1: Demonstrate an understanding of brake systems.**

**Range:**
- *This topic and this subject outcome are restricted to the following brake systems: disc, drum, thruster and electromagnetic brake systems.*
- *Simple line sketches may be used to explain and describe the working principles of types of brake systems.*

**Learning Outcomes:**

The student should be able to:
- Explain the function and purpose of brake systems and compare these with couplings.
- Explain the working principles of different types of brake systems.
- Describe the application of different types of brake systems.
• Explain the advantages and disadvantages of using one type of brake system instead of another.

**Subject Outcome 3.2: Demonstrate an understanding of clutches.**

*RANGE:*

- *This topic and this subject outcome are restricted to friction clutch systems: single and multi-plate, centrifugal (loose weight and fixed weight types), cone and torque-limiter.*
- *Simple line sketches may be used to explain and describe the working principles of clutch-types.*

**Learning Outcomes:**

The student should be able to:

- Explain the function and purpose of clutches and compare these with couplings.
- Explain the working principles of different types of clutch systems.
- Describe the application of different types of clutches.
- Explain the advantages and disadvantages of using one type of clutch system instead of another.

**Subject Outcome 3.3: Explain correct safety procedures and care during the removal, replacement and maintenance of brakes and clutch systems.**

*RANGE:*

- *Safety procedures include excerpts from the Driven Machinery Regulations. Safety measures include the impact on human beings, machines, equipment, materials and the environment.*
- *Safety includes the application of personal protective equipment, during dismantling, repair, mounting or checking, start-up procedures, protective guards and other best practice procedures.*

**Learning Outcomes:**

The student should be able to:

- Explain worksite health and safety practices for brake and clutch maintenance.
- Explain the need for good housekeeping.
- Explain the importance of a clean working area and the appropriate use of cleaning materials.
- Identify the appropriate safety clothes and masks and explain their importance.

**Subject Outcome 3.4: Plan and prepare for brake and clutch maintenance.**

**Learning Outcomes:**

The student should be able to:

- Read and interpret the job card.
- Obtain relevant documents.
- Interpret engineering drawings.
- Schedule maintenance procedures.
- Select appropriate tools and equipment.
- Clean and inspect the complete assembly.
- Identify the wear on the linings and score marks on the friction surface.
- Isolate equipment electrically from other energy sources.
- Isolate equipment mechanically from other energy sources.
• Support the load before the brake or clutch is released, removed, adjusted, lowered or worked on.

**Subject Outcome 3.5: Demonstrate an understanding of brake and clutch inspection and checking**

**Learning Outcomes:**
The student should be able to:
• Inspect assemblies for conformance to manufacturer’s specifications.
• Measure the air gaps according to manufacturer’s specifications.
• Inspect the hydraulic systems for leaks.
• Inspect the friction area for wear.
• Measure and adjust brakes and clutches according to manufacturer’s specifications.
• Apply appropriate safety practices during the process.

**Topic 4: Belt Drives**

**Subject Outcome 4.1: Demonstrate an understanding of v-belt drives**

**Range:**
• Types of v-belts and v-belt drives are identified according to manufacturers’ specification and design and includes the use of v-belt drive terms, components and functions from given drawings.
• Students must be exposed (briefly) to different types of belts (example: flat-, tooth-, wedge-types)
• Factors determining selection of v-belts; application of V-belts; advantages and disadvantages of v-belt drives when compared with chain and gear drives.
• Common and special v-belt types and their composition are represented by means of a sectional drawing. Includes SPZ; SPA; SPB; and SPC types only.
• Sketches may include v-belt pulleys for single and multiple belt drives and include driven pulley, drive pulley, jockey, idler, centre distance, belt tension in kg/m² or Newton.

**Learning Outcomes:**
The student should be able to:
• Explain the application of v-belts.
• Explain the advantages and disadvantages of v-belt drives over chain and gear drives.
• Name common and special v-belt types.
• Identify v-belt drive terms and indicate components from given drawings
• Explain v-belt drive terms and functions of components.
• Use a sectional drawing to present the composition of a v-belt.
• Use a simple drawing to distinguish between v-belt pulleys for single and multiple belt drives.

**Subject Outcome 4.2: Explain correct safety procedures and care when working with v-belt drives.**

**Range:**
• Safety procedures include excerpts from the Driven Machinery Regulations. Safety measures include the impact on human beings, machines, equipment, materials and the environment.
• Belt drive safety includes the use of personal protective equipment, safety precautions for mounting, removal, disassembly, start-up procedures, protective guards and other best
practice procedures.

- V-belts are listed as transmission belts in the Driven Machinery Regulations

**Learning Outcomes:**
The student should be able to:
- Explain worksite health and safety practices when working with v-belt drives.
- Explain good housekeeping.
- Explain the safety precautions to take when working with v-belt drives
- Identify appropriate personal protective equipment and explain its importance.
- Explain the importance of a clean working area and the need for effective cleaning of equipment, materials and machines.

**Subject Outcome 4.3: Plan and prepare for v-belt maintenance.**

**Learning Outcomes:**
The student should be able to:
- Read and interpret a job card, obtain documentation and interpret engineering drawings.
- Identify personnel requirements and schedule maintenance procedures.
- Select appropriate tools and equipment.
- Clean and inspect the complete assembly.
- List the potential areas of defectiveness and wear.
- Isolate equipment electrically from other energy sources.
- Isolate equipment mechanically from other energy sources.

**Subject Outcome 4.4: Dismantle and assemble v-belt drives**

**Range:**
This may include: Checking of v-belt sizes and lengths; maintenance, fault finding and diagnosis; alignment and tensioning; installation of v-belt drives; elimination and accommodation of belt deflection

**Learning Outcomes:**
The student should be able to:
- Disassemble the v-belt drive.
- Identify v-belt drive assembly components.
- Remove the belt drive assembly
- Inspect parts for non-conformances.
- Clean parts.
- Assemble the belt drive assembly and components.
- Apply appropriate safety practices during the process.

**Subject Outcome 4.5: Perform quality checks and job completion procedures**

**Learning Outcomes:**
The student should be able to:
- Conduct quality checks.
- Measure and test replacement parts and evaluate performance.
- Record information accurately on the completed job.
- Open a new file and name it or use an existing file and store information in a safe place.
- Clean and maintain equipment and tools.
- Report on defective tools and equipment and facilitate discard procedures or repair.
- Store equipment and tools in an authorised place.

**Topic 5: Chain Drives**

**Subject Outcome 5.1: Demonstrate an understanding of chain drives**

*Range:*
- Types of chain and chain drives are identified according to manufacturers’ specifications and design and includes the use of chain drive terms, components and functions from given drawings.
- Factors determining selection of chain and chain drive types; application of chain-types; advantages and disadvantages of chain drives when compared with v-belt and gear drives.
- Chain terms include drive and driven sprockets, drive motor, idlers and tensioners, roller chain terms (bearing pins, outer plates, inner plates bushes, rollers), chain pitch, pin diameter, roller diameter, link plates and thickness, chain width.
- Drive terms and functions of components are explained.
- Common and special chain and sprocket types and their composition are represented by means of a sectional drawing.
- Sketches may include chain sprockets for chain drives (sprocket-types; sprocket bearings, sprocket alignment) and link-types (precision roller; double-pitch-; silent-; leaf-types)
- The following procedures must be explained: checking of chain sizes and lengths; maintenance; fault finding and diagnosis; alignment and tensioning; installation of chain drives; description and explanation of chain deflection.

**Learning Outcomes:**
The student should be able to:
- Explain the application of chain drives.
- List the advantages and disadvantages of chain drives in comparison to v-belt and gear drives.
- Identify chain components from given drawings using correct terms.
- Use chain drive terms to describe functions of components.
- Name the common and special chain and sprocket types.
- Use a sectional drawing to illustrate the composition of a chain
- Use a simple sectional drawing to distinguish between chain drive sprocket types for single and multiple chain drives.

**Subject Outcome 5.2: Explain correct safety procedures and care when working with chain drives.**

*Range:*
- Safety procedures include excerpts from the Driven Machinery Regulations. Safety measures include the impact on human beings, machines, equipment, materials and the environment.
- Chain drive safety includes the application of personal protective equipment, safety precautions for mounting, removal, disassembly, start-up procedures, protective guards and other best practice procedures.
- Chains are listed as transmission belts in the Driven Machinery Regulations

**Learning Outcomes:**
The student should be able to:
• Explain worksite health and safety practices when working with chain drives.
• Explain good housekeeping.
• Explain the safety precautions to take when working with chain drives.
• Identify appropriate personal protective equipment and explain its importance.
• Explain the importance of a clean working area and the need for effective cleaning equipment, materials and machines.

Subject Outcome 5.3: Plan and prepare for chain drive maintenance.

Learning Outcomes:
The student should be able to:
• Read and interpret the job card, obtain documentation and interpret engineering drawings.
• Identify personnel requirements and schedule maintenance procedures.
• Select appropriate tools and equipment.
• Clean and inspect the complete assembly.
• List the potential areas of defectiveness and wear.
• Isolate equipment electrically from other energy sources.
• Isolate equipment mechanically from other energy sources.

Subject Outcome 5.4: Dismantle and assemble chain drives

Range:
• This task may be simulated with a typical workshop chain drive station.
• A simplex chain may be used for this purpose.
• Alignment method should be basic - with the aid of an engineering square, feather gauge and feelers (clock gauge is optional)
• Maintenance includes: Checking of chain sizes and lengths; alignment and tensioning; installation of chain drives; elimination and accommodation of chain deflection and/or sag; elongation due to wear.
• Chain lubrication methods: manual, drip-, bath-, disc-, and oil-stream lubrication

Learning Outcomes:
The student should be able to:
• Disassemble the chain drive.
• Identify chain drive assembly components.
• Remove the chain drive assembly
• Inspect parts for non-conformances.
• Clean the parts.
• Assemble the chain drive assembly and components.
• Clean and overhaul chain lubrication device or mechanism
• Apply appropriate safety practices during the process.

Subject Outcome 5.5: Perform quality checks and job completion procedures

Learning Outcomes:
The student should be able to:
• Conduct quality checks.
• Clean and maintain equipment and tools.
• Report on defective tools and equipment and facilitate discard procedures or repair.
• Store equipment and tools in an authorised place.
Topic 6: Gear Drives

Subject Outcome 6.1: Demonstrate an understanding of gear drives

Range:
- Gear drives include rack and pinion, spur-, bevel-, worm and worm-wheel-, helical and double helical-, hypoid-types.
- Gear assemblies include simple and compound gear trains.
- Reduction gearboxes include: single and double reduction gearboxes; worm and worm-wheel reduction gearboxes.
- Terminology includes drive and driven gears, input and output shafts, gear housing/casing, lubrication, bearings.

Learning Outcomes:
The student should be able to:
- Explain the application and functions of gear drives using appropriate terminology.
- List the advantages and disadvantages of gear drives in comparison to v-belt and chain drives.
- Use line drawings to distinguish between cycloid- and involute-generated gear teeth profiles.
- Explain the principle of velocity ratio and mechanical advantage in gear assemblies.
- Explain the purpose of intermediate gears.
- List the factors which determine the correct mesh of gear teeth.
- Distinguish between simple and compound gear trains.
- Explain the application of reduction gearboxes.
- Identify, name and label the main components of a typical reduction gearbox.

Subject Outcome 6.2: Explain correct safety procedures and care when working with gear drives.

Range:
- Safety procedures include excerpts from the Driven Machinery Regulations. Safety measures include the impact on human beings, machines, equipment, materials and the environment.
- Gear drive safety includes the application of personal protective equipment, safety precautions for mounting, removal, disassembly, start-up procedures, protective guards and other best practice procedures.

Learning Outcomes:
The student should be able to:
- Explain worksite health and safety practices when working with gear drives.
- Explain good housekeeping.
- Explain the safety precautions to take when working with gear drives.
- Identify appropriate personal protective equipment and explain its importance.
- Explain the importance of a clean working area and the need for effective cleaning equipment, materials and machines.

Subject Outcome 6.3: Plan and prepare for gear drive maintenance.

Learning Outcomes:
The student should be able to:
- Read and interpret the job card, obtain documentation and interpret engineering drawings.
- Identify personnel requirements and schedule maintenance procedures.
- Select appropriate tools and equipment.
- Clean and inspect the complete assembly.
- List the potential areas of defectiveness and wear.
- Isolate equipment electrically from other energy sources.
- Isolate equipment mechanically from other energy sources.

**Subject Outcome 6.4: Dismantle and assemble a gear drive**

*Range:*
- This task may be simulated with a typical workshop chain drive station.
- A typical worm reduction unit may be used for this purpose.

**Learning Outcomes:**
The student should be able to:
- Disassemble the gear drive.
- Identify gear drive assembly components.
- Remove the gear drive assembly.
- Inspect parts for non-conformances.
- Clean the parts.
- Assemble the gear drive assembly and components.
- Clean and replenish gear lubricant.
- Apply appropriate safety practices during the process.

**Subject Outcome 6.5: Perform quality checks and job completion procedures**

**Learning Outcomes:**
The student should be able to:
- Conduct quality checks.
- Clean and maintain equipment and tools.
- Report on defective tools and equipment and facilitate discard procedures or repair.
- Store equipment and tools in an authorised place.

**Subject Outcome 7.1: Demonstrate an understanding of pipes and pipe-fittings**

*Range:*
- Pipe sizing terminology includes pipe length, inside diameter (ID), outside diameter (OD), wall thickness, nominal bore (NB), reference of the term “scheduled pipe”, reading of a pipe specification chart, pipe-spool.
- Pipe fittings include elbow, tee, cross, socket, barrel nipple, plug, cap, reducing socket.
- Joining methods for steel water pipes and plastic water pipes include screw-threaded, welded, flanged, bell- and spigot, butt- and strap joint and threaded union-types.
- The two different types of plastic piping: Thermoplastic piping; Thermosetting plastic piping.
- Joining methods for pipe-lines include socket fusion, butt-welding, compression jointing and sealing with the aid of o-ring seals.
- Pipe-fitting tools include pipe-cutter and pipe reamer.
• **Methods used to accommodate expansion in pipe-lines include expansion diaphragm, pipe suspension on rollers, telescopic expansion joint, corrugated expansion joint and the application of expansion bends and loops (creased bend-, full loop-, horseshoe- and expansion-types)**

**Learning Outcomes:**

The student should be able to:

- Use correct terminology associated with pipe sizing.
- Identify various pipe fittings and explain where they are used.
- Explain various joining methods for steel water pipes and plastic water pipes.
- Distinguish two different types of plastic piping.
- Explain the advantages and disadvantages of plastic piping.
- Describe briefly how pipe cutters and reamers are used.
- Describe materials used to seal threaded pipes.
- Describe and explain the joining methods for pipe-lines.
- Provide reasons for the failure of flanged joints.

**Subject Outcome 7.2: Explain correct safety procedures and care when working with pipes and pipe fittings.**

**Range:**

- **Safety procedures include excerpts from the Driven Machinery Regulations. Safety measures include the impact on human beings, machines, equipment, materials and the environment.**
- **Pipe-fitting safety includes the application of personal protective equipment, safety precautions for mounting, removal, disassembly and other best practice procedures.**

**Learning Outcomes:**

The student should be able to:

- Explain worksite health and safety practices when working with pipes and pipe fittings.
- Explain good housekeeping.
- Explain safety precautions to take when working with pipes and pipe-fittings.
- Identify appropriate personal protective equipment and explain its importance.
- Explain the importance of a clean working area and the need for effective cleaning equipment, materials and machines.

**Subject Outcome 7.3: Plan and prepare for pipe/pipe-line maintenance.**

**Learning Outcomes:**

The student should be able to:

- Read and interpret a job card, obtain documentation and interpret engineering drawings.
- Identify personnel requirements and schedule maintenance procedures (clearance acceptance/permit).
- Select appropriate tools and equipment.
- Clean and inspect the complete assembly.
- List the potential areas of hazard.
Subject Outcome 7.4: Dismantle and assemble pipes and pipe-lines

**Range:**
- This task may be simulated within a pipe installation station in the training workshop.
- This pipe installation may be connected to a pump system for this purpose.

**Learning Outcomes:**
The student should be able to:
- Disassemble the pipe/pipe-line.
- Identify pipe/pipe-line assembly components.
- Remove the pipe/pipe-line assembly
- Inspect parts for non-conformances.
- Clean the parts.
- Assemble the pipe/pipe-line assembly and components.
- Apply appropriate safety practices during the process.

Subject Outcome 7.5: Perform quality checks and job completion procedures

**Learning Outcomes:**
The student should be able to:
- Conduct quality checks.
- Measure and test replacement parts and evaluate performance.
- Clean and maintain equipment and tools.
- Report on defective tools and equipment and facilitate discard procedures or repair.
- Store equipment and tools in an authorised place.

Topic 8: Valves

Subject Outcome 8.1: Demonstrate an understanding of valves

**Range:**
- Includes valves used in water, gas, steam and high air-pressure installations; includes gate valve, diaphragm valve, safety valves for gas and steam pipelines, relief valve for liquids, non-return valve, butterfly valve, ball valve, foot valve.

**Learning Outcomes:**
The student should be able to:
- Explain the function of a valve and its working principles.
- Identify, name and label valves.
- Describe the working principles of the various types of valves.

Subject Outcome 8.2: Explain correct safety procedures and care when working with valves.

**Range:**
- Safety procedures include excerpts from the Driven Machinery Regulations. Safety measures include the impact on human beings, machines, equipment, materials and the environment.
- Valve-fitting safety includes the application of personal protective equipment, safety precautions for mounting, removal, disassembly and other best practice procedures.
Learning Outcomes:
The student should be able to:
• Explain worksite health and safety practices when working with valves.
• Explain good housekeeping.
• Explain the safety precautions to take when working with valves.
• Explain the importance of a clean working area and the need for effective cleaning equipment, materials and machines.
• Identify appropriate personal protective equipment and explain its importance.

Subject Outcome 8.3: Plan and prepare for valve maintenance.

Learning Outcomes:
The student should be able to:
• Read and interpret a job card, obtain documentation and interpret engineering drawings.
• Identify personnel requirements and schedule maintenance procedures (clearance acceptance/permit)
• Select appropriate tools and equipment.
• Clean and inspect the complete assembly.
• List the potential areas of hazard.

Subject Outcome 8.4: Dismantle and assemble valves

Range:
• This task may be simulated within a pipe installation station in the training workshop.
• The pipe installation may be connected to a pump system for this purpose.
• Recommended: After assembly and fitting, lecturers are encouraged to use the valve/s in order to demonstrate the shut-off and by-pass of fluid flow with the aid of the valves used in the task.

Learning Outcomes:
The student should be able to:
• Disassemble the valve.
• Identify valve-assembly components.
• Remove the valve-assembly
• Inspect parts for non-conformances.
• Clean the parts.
• Assemble the pipe/pipe-line assembly and components.
• Apply appropriate safety practices during the process.

Subject Outcome 8.5: Perform quality checks and job completion procedures

Learning Outcomes:
The student should be able to:
• Conduct quality checks.
• Measure and test replacement parts and evaluate performance.
• Accurately record information on completed job.
• Clean and maintain equipment and tools.
• Report on defective tools and equipment and facilitate discard procedures or repair.
• Store equipment and tools in an authorized place.
Topic 9: Centre Lathe

Subject Outcome 9.1: Follow safety rules and maintain safety precautions

Learning Outcomes:
The student should be able to:
- Wear and use appropriate clothing.
- Check the placement of the machine guards.
- Clear the work area to allow adequate space.
- Check that the lathe machine is switched off when loading and unloading a work piece, when taking measurements and during cleaning.
- Use a guard or shield to deflect chips.
- Clean the work area of chips, spills and fluids.

Subject Outcome 9.2: Prepare operation sheet

Range
- *HM cutting to be introduced with use of minimum depth of cut 1.0 (nose radius of cutting tool)*
- *Max feed for roughing and depth to be applied for HM cutting tool*
- *Finishing cut must be minimum nose radius*
- *Feed in finishing cut must be set according to surface specification*

Learning Outcomes:
The student should be able to:
- Identify the proper machining sequence
- Identify the workpiece material.
- Determine the workpiece diameter
- Select the correct type of cutting tool.
- Choose cutting speeds as per the specifications
- Calculate the RPM according to roughing/finishing
- Calculate the depth of cut according to roughing/finishing
- Turn within tolerance as per the drawing ± 0.1mm

Subject Outcome 9.3: Prepare for work activity.

Learning Outcomes:
The student should be able to:
- Select tools and equipment required for lathe operation.
- Check whether tools and equipment are in good working condition.
- Maintain oil and lubricate the lathe according to specifications.
- Check whether the machine is in good working condition.
- Achieve competence in the use of the handles gearbox and spindle settings.

Subject Outcome 9.4: Set the lathe.

Learning Outcomes:
The student should be able to:
- Set out all tooling requirements for the task.
- Fit the selected cutter in the tool post and adjust the cutter height.
- Set the graduated sleeve of the cross-slide to zero.
- Set the compound slide to zero.
• Position the carriage for cutting.
• Clamp the work pieces securely and check the set-up

Subject Outcome 9.5: Perform turning operations.

Range:
• Turning task should include taper turning with the use of the compound slide. The task should be simple and may include grooving and parting.
• Tolerance is ± 0.1 mm at this level.
• All work is performed using a 3-jaw chuck.

Learning Outcomes:
The student should be able to:
• Adjust to the calculated RPM setting.
• Adjust the feed rate.
• Set the cutter against the work piece and adjust the cutting depth.
• Engage automatic or manual feed.
• Flood the cutter with coolant when using the HSS tool.
• Perform facing, longitudinal turning, and grooving operations (knurling is optional).
• Turn the work piece to tolerances of ± 0.1 mm.
• Remove the machined component on completion of the turning process.

Subject Outcome 9.6: 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 for correctness according to specifications.

Subject Outcome 9.7: 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.

Topic 10: Milling Machine

Subject Outcome 10.1: Follow safety rules and maintain safety precautions

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

Subject Outcome 10.2: Prepare an operation sheet
Learning Outcomes:
The student should be able to:
• Identify the proper machining sequence
• Identify the type of 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
• Determine the dividing head settings for rapid indexing
• Specify an appropriate tolerance as per the drawing ± 0.1 mm.

Subject Outcome 10.3: Prepare for work activity.
Learning Outcomes:
The student should be able to:
• Prepare the machine for operation, including lubrication and routine maintenance.
• Conduct pre-operational checks.
• Ensure that appropriate materials and tools required are available.
• Ensure that cutting fluid is available.

Subject Outcome 10.4: Set the milling machine
Learning Outcomes:
The student should be able to:
• Mount the appropriate cutting tool
  Range: HSS – end-milling cutter, slot-drill / slotting cutter
• Set the clamping arrangement.
• Mount and position the work piece correctly (for cutting or direct indexing)
• Set the table X and Y axes perpendicular to spindle axis.
• Set the fixed jaw of the vice parallel to the X axis.
• Select and set cutting speeds and feeds according to the operation sheet.
• Mount the work piece
• Prepare and set up the dividing head for the task.
  Range: The milling task is limited to the rapid indexing method.

Subject Outcome 10.5: Perform milling operations.
Range:
• Milling task should include the machining of flat surfaces (quadrangular/hexagonal) with the use of the rapid indexing method and may include a slotting task.
• Tolerance is ± 0.1 mm at this level.
• Ensure the “clocking” of the vice for all machining procedures(parallel/perpendicular to all reference faces)

Learning Outcomes:
The student should be able to:
• Set and position the cutter and set the cutting depth and width.
• Set graduated dials to zero.
• Adjust the dividing head according to the number of sides to be cut.
• Monitor the milling machine while in operation.
• Adjust speeds and feeds where required.
• Flood the cutter with coolant when using the HSS tool.
• Use automatic or manual feed.
• Perform flat and slot milling within a tolerance of ± 0.1 mm.
• Tighten the head after each indexing.
• Remove the work piece after machining.
• Clean the milling machine after completion of the job.

Subject Outcome 10.6: Perform quality checks on the machined component.

Learning Outcomes:
The student should be able to:
• Select the correct tools and equipment to perform a quality check.
• Identify values for checking.
• Check cutting surface finish.
• Inspect the machined component for conformance to the specifications as per assessment sheet and drawing.
• Document conformance of the machined component to specifications.

Subject Outcome 10.7: 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 MACHINING – LEVEL 3

8.1 Physical resources
• Classroom/lecture room equipped with teaching aids;
• Suitably equipped workshop for fitting and machining (see Appendix 9.3 and 9.4);
• Store room for consumables, attachments and fixtures, portable power tools and related equipment;
• Pre-designed models.

8.2 Human resources
It is recommended that a lecturer in Fitting and Machining – Level 3 must be
• A subject matter expert (with an artisan qualification);
• In possession of a NQF Level 5 teaching qualification;
• Competent in facilitation and group learning methodologies;
• Familiar with OBE methodologies;
• Knowledgeable in learning and assessment requirements of the FET college for this learning program (prior to commencement).

It is of paramount importance that facilitators/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

8.3.1 Any alternate consumables and equipment which may be required.

8.3.2 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. Appendices

9.1 Assessment sheet for turning exercises
9.2 Machining procedure - description
9.3 Fitter – physical resources
9.4 Machinist – physical resources
### Appendix 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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<tbody>
<tr>
<td>102</td>
<td>± 0.2</td>
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<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>60</td>
<td>±0.2</td>
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<tr>
<td>10</td>
<td>±0.2</td>
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</tr>
<tr>
<td>4.5</td>
<td>±0.1</td>
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<tr>
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<td>0 +0.4</td>
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<tr>
<td>45</td>
<td>±1</td>
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Total no. of point out of points: 0
### Appendix 9.2: Operation description Task 4 (Exemplar)

<table>
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<tr>
<th>No.</th>
<th>Operation:</th>
<th>Vc</th>
<th>Fn</th>
<th>n</th>
<th>Ap</th>
<th>D</th>
<th>L</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Facing HM finishing tool</td>
<td>100</td>
<td>0.1</td>
<td>796</td>
<td>1</td>
<td>40</td>
<td>20</td>
<td>15</td>
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<tr>
<td>2.0</td>
<td>Longitudinal turning finishing HM tool</td>
<td>100</td>
<td>0.1</td>
<td>838</td>
<td>1</td>
<td>38</td>
<td>45</td>
<td>0.54</td>
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<tr>
<td>2.1</td>
<td>Change tool to grooving tool ϕ4mm</td>
<td>100</td>
<td>0.1</td>
<td>885</td>
<td>1</td>
<td>36</td>
<td>45</td>
<td>0.51</td>
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<td>3.0</td>
<td>Cutting the groove</td>
<td>50</td>
<td>hand</td>
<td>531</td>
<td>30</td>
<td>4.5</td>
<td>3</td>
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<tr>
<td>4.0</td>
<td>Drill hole ϕ8.5mm</td>
<td>25</td>
<td>hand</td>
<td>937</td>
<td>8.5</td>
<td>45</td>
<td>3</td>
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<td>5.0</td>
<td>Cut the thread tap10</td>
<td>hand</td>
<td>35</td>
<td>35</td>
<td>3</td>
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<td>6.0</td>
<td>Centre drill HSSϕ8mm</td>
<td>25</td>
<td>hand</td>
<td>500</td>
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<td>7.0</td>
<td>Longitudinal turning roughing HM tool</td>
<td>100</td>
<td>0.25</td>
<td>995</td>
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<td>32</td>
<td>60</td>
<td>0.24</td>
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<td>7.1</td>
<td>Turning Fishing</td>
<td>120</td>
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<td>28</td>
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<td>Longitudinal turning roughing HM tool</td>
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<td>15</td>
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</table>

**Self-assessment**

2
## Appendix 9.3: Physical Resources for Fitting

The table below provides a list of tools and equipment required for fitting and turning, with the quantities (QTY) and pricing per unit (UNIT PRICE) indicated. The total amount (AMOUNT) is calculated by multiplying the quantity by the unit price.

<table>
<thead>
<tr>
<th>No.</th>
<th>Tools</th>
<th>QTY</th>
<th>UNIT PRICE</th>
<th>AMOUNT</th>
</tr>
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<tbody>
<tr>
<td>A</td>
<td>SECTION A: TOOL LIST</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>SECTION B: MARKING / MEASURING EQUIPMENT</td>
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</tr>
<tr>
<td>1</td>
<td>Vernier height gauge</td>
<td>2</td>
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</tr>
<tr>
<td>2</td>
<td>Marking off/surface table, large</td>
<td>1</td>
<td></td>
<td></td>
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<tr>
<td>C</td>
<td>SECTION C: WORKSHOP EQUIPMENT</td>
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</tr>
<tr>
<td>3</td>
<td>Portable drilling machine</td>
<td>5</td>
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<tr>
<td>4</td>
<td>Portable grinding machine</td>
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</tr>
<tr>
<td>5</td>
<td>Portable angle grinder</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Portable Jig-saw</td>
<td>5</td>
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</tr>
<tr>
<td>7</td>
<td>Compressor, hose, couplings and fittings</td>
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</tr>
<tr>
<td>8</td>
<td>Column drill press</td>
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<tr>
<td>9</td>
<td>Radial drill press</td>
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<tr>
<td>10</td>
<td>Bench grinder</td>
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<tr>
<td>D</td>
<td>SECTION D: ARC WELDING PROCESS EQUIPMENT</td>
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<td>13</td>
<td>Bearing training station</td>
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<tr>
<td>14</td>
<td>Lubrication training station</td>
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<tr>
<td>15</td>
<td>Pumps training station</td>
<td>5</td>
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<tr>
<td>16</td>
<td>Belt-drive training station</td>
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<tr>
<td>17</td>
<td>Chain-drive training station</td>
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<tr>
<td>18</td>
<td>Gear-drive training station</td>
<td>5</td>
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<tr>
<td>19</td>
<td>Pipes, gaskets, seals and valve training station</td>
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<tr>
<td>20</td>
<td>Coupling training station</td>
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<td>21</td>
<td>Brakes and clutches training station</td>
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<tr>
<td>E</td>
<td>SECTION E: BASIC RIGGING EQUIPMENT</td>
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<tr>
<td>22</td>
<td>Share with fabrication/welding workshop</td>
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<td>F</td>
<td>SECTION F: FLUID POWER</td>
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<td>23</td>
<td>Hydraulics training rig and components</td>
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<td>Pneumatics training rig and components</td>
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<td>G</td>
<td>SECTION G: OHS ACT COMPLIANCE</td>
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<td>25</td>
<td>Overall</td>
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<td>26</td>
<td>Safety Boots</td>
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## Appendix 9.4: Physical Resources – Machining (Turner)

### TURNER EQUIPMENT AND TOOL LIST X 10 LEARNERS

#### TOOLS, EQUIPMENT AND MACHINERY PRICING SHEET

<table>
<thead>
<tr>
<th>No.</th>
<th>Tools</th>
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<th>UNIT PRICE</th>
<th>AMOUNT</th>
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