THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
DEPARTMENT OF MECHANICAL ENGINEERING

MEC 3102 MACHINE TOOLS AND PRINCIPLES OF ELECTRICITY II
MACHINE TOOLS
Laboratory No. 1.

Orthogonal Cutting Analyzed with a Two Component Lathe Tool Dynamometer.

Date of Laboratory: Monday, 17th October 2022
Venue: Mechanical Engineering Machine Shop
Time: 08.00 to 11.00 hours

1. OBJECTIVES:

i. To measure the cutting forces $\boldsymbol{F_c}$, and $\boldsymbol{F_a}$, in two perpendicular directions, (ii)

ii. To determine the influence of:

a) Depth of cut $\boldsymbol{d}$

b) Feed rate $\boldsymbol{f}$

c) Cutting velocity $\boldsymbol{V_c}$

d) Rake angle $\boldsymbol{\alpha}$ of the cutting tool on the cutting forces

iii. To compare the practical results with the theoretically obtained values of $\boldsymbol{F_c}$ and $\boldsymbol{F_a}$.

2. APPARATUS:

i. Specify the lathe used and list the apparatus.

ii. Sketch and describe the lathe dynamometer. The sketch should include clear indication of the force vectors $\boldsymbol{F_c}$ and $\boldsymbol{F_a}$ that are measured. Sketch and describe the experiment set up.

3. THEORY

Refer to lecture notes for single point cutting theory. Refer to text books.

4. PROCEDURE:

a) Calibrate the lathe dynamometer for both directions. Explain the calibration process for the force sensors in your report.
b) Remove the compound slide.
c) Align the dynamometer.
d) Mount the correct tool and set it to the correct overhang L.

$$\boldsymbol{L = 10.16mm \pm \frac{1}{2}(depth\ of\ cut)}$$

e) Check the working of the electronic gauge.
f) Conduct actual tests and record deflections which are to be converted to forces for conditions set in Tests 4.1 to 4.5 below.

4.1. Variable depth of cut $\boldsymbol{d}$

Speed: $\mathbf{n = 125 rev/min}$

Feed $\mathbf{f = 0.13 mm/rev}$

Rake angle $\boldsymbol{\alpha = +10°}$

Work piece diameter $\boldsymbol{D = 65mm}$ D=65 mm (measure actual diameter workpiece)

Depth of cut $\boldsymbol{d = 1, 1.75, 2.50, 3.25, 4\ mm}$

4.2. Variable tool feed $\boldsymbol{f}$

Speed: $\boldsymbol{n = 125 rev/min}$

Depth of cut $\boldsymbol{d = 2.5\ mm}$

Work piece diameter $\boldsymbol{D = 65\ mm}$ (measure actual work piece diameter) Rake Rake angle $\boldsymbol{\alpha = +10°}$

Feed $\boldsymbol{f = 0.13, 0.11; 0.097; 0.084; 0.070\ mm/rev}$

4.3. Variable Cutting Speed V_c

Depth of cut $\boldsymbol{d = 2.5\ mm}$

Work piece diameter $\boldsymbol{D = 65\ mm}$ (measure actual diameter)

Rake angle $\boldsymbol{\alpha = +10°}$

Speed: $\boldsymbol{n = 80, 125, 160, 200, 315, 400\ rev/min}$

Feed $\boldsymbol{f = 0.070\ mm/rev}$

4.4. Variable tool rake angle a

Speed: $\boldsymbol{n = 125\ rev/min}$

Feed $\boldsymbol{f = 0.14\ mm/rev}$

Depth of cut **d = 2.5 mm**

Workpiece diameter $\boldsymbol{D = 65\ mm}$ (measure actual workpiece diameter)

Rake angle $\boldsymbol{\alpha = 0°, 5°, 10°, 15°, 20°, 25°}$

Collect sample chips for known cutting parameters for use in Section 4.5. The chip thicknesses should be measured using a dial type **vernier caliper**.

4.5. Chip ratio

For test 4.4 collect chips from known lengths/diameter of work-piece, **depth of feed** and measure the chip thicknesses in order to calculate **chip cutting ratios**.

5. RESULTS:

i. All results for Experiments 4.1 to 4.5 should be presented in tabular and graphical forms.

ii. Calculate the theoretical cutting forces $\boldsymbol{F_c}$ and $\boldsymbol{F_a}$ for **Test 4.1** with of cut $\boldsymbol{d}$ of 2.50, 3.25 and 4.0 mm.

iii. Derive from the results of **Test 4.4** the power consumption for the cutting action and plot a graph of **power consumption** as a function of the **rake angle**.

iv. For **Test 4.5** calculate the power expended in overcoming chip/tool friction.

v. Use results of **Tests 4.4** and **4.5** to verify Merchant's hypothesis given by the expression:

$$\boldsymbol{C = 2\phi + \tau - \alpha}$$

Give a Table representing the various values of $\boldsymbol{\phi, \tau, c}$ for each rake angle $\boldsymbol{\alpha}$ in **Test 4.4**. Plot the values of C versus $\boldsymbol{\alpha}$.

6. DISCUSSIONS

Discuss all results from the tests. Discuss the verification of Merchant's hypothesis.

7. CONCLUSIONS:

Draw Conclusions from the Results of each Test.

8. REFERENCES

Give references.

Dr. V. Musonda

17/10/22

Submit Laboratory **by 24/10/22**

Quality of the Lab Report and Format should be of acceptable university standard.