Experiment No.: 5

Experiment title: Tool Wear and Surface Roughness in Machining

Objectives:

- Familiarity with the concept of tool wear
- Familiarity with determining tool wear
- Familiarity with the concept of surface roughness and its measurement calculations
- Appreciation of the effect of machining parameters and conditions on tool wear and surface characteristics

Expected outcomes: at the end of this experiment the students should be able to:

- Determine the amount of tool wear after each machining operations
- Calculate the relevant constants for different tool type-work piece material combinations
- Measure and calculate the surface roughness machined and worked surfaces using different equations
- Relate machining conditions to the amount of tool wear and surface roughness

Theoretical background:

Tool wear

For flank wear: $$VT^{n} = C$$

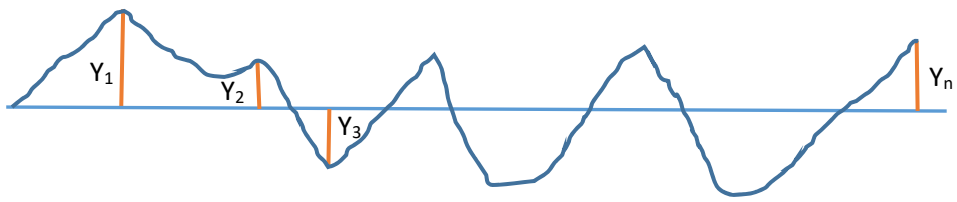
Where:

V: Cutting speed m/min

T: cutting time in minutes

N and C: constants for each tool-type, work piece material and cutting conditions combination

Surface roughness:



Arithmetic mean value: $$R_a = \frac{|y_1| + |y_2| + |y_3| + ... + |y_n|}{n}$$

Root-mean square average: $$R_q = \sqrt{\frac{y_1^2 + y_2^2 + y_3^2 + ... + y_n^2}{n}}$$

Materials and Equipment:

- Milling Machine
- Lathe (turning machine)
- One of round and one flat aluminium work pieces
- One carbide turning tool
- One HSS turning tool
- Stopwatch
- One end-mill / surface milling cutter
- Precision balance (0.001g)
- Surface Profilometer

Experimental Procedure:

a- Tool weal

1- Make sure you are wearing necessary personal safety equipment (goggles, lab coat, etc.)

2- Take the round specimen and make three measurements for its diameter, find the average and record it in Table (1)

3- Take the HSS turning tool and weight it in the precision balance, make sure to reset the balance before weighing and that it is setup appropriately. Take two measurements and record the average in Table (1)

4- Give the HSS tool back to the technician and watch the technician load the tool onto the tool holder on the lathe machine

5- Watch the technician setting up the turning operation by bringing the tool at the face of the specimen

6- Record the rotational speed “N” (in rpm) and feed rate (in mm/revolution) in Table (1)

7- Get your stopwatch ready and ask the technician to give you a signal one he starts the machining so that you turn the stopwatch on

8- Ask the technician to give you a signal at the end of machining so that you stop the stopwatch

9- Record the time (in minutes) in Table (1)

10- Ask the technician to unload the HSS tool and make a weight measurement after the first pass; as in point 3. Make sure the tool is clean of any metallic chips or residues. If you notice an increase in weight make sure you remove any build-up edge (BUE) and redo the weighing

11- Measure the diameter of the machined specimen as in point 2

12- Find the average for the initial and the final diameters (D_{ave}) and calculate the cutting speed in mm/minute ($V = \pi D_{ave} N$) and record it in Table (1)

13- Repeat steps 2 – 12 at the same cutting speed and record your values in Table (1)

14- Repeat steps 2 – 13 at a different cutting speed until you have the same amount of tool wear (weight loss)

15- From the data obtained for the two cutting speeds calculate **C** and **n** for this combination of

16- Repeat steps 2 – 15 for the carbide-type cutting tool

- List expected sources of error
- Right your own conclusion and comment on the results

Table (1): Experimental measurements for the tool wear specimens

Tool type	**V (mm/min)**	**Time (min)**	**Weight loss (gram)**	**Time (min)**	**Weight loss (gram)**	**Time (min)**	**Weight loss (gram)**	**Total time (min)**	**Total weight loss (g)**
HSS									
HSS									
Carbide									
Carbide									

b- Surface roughness

1- Make sure you are wearing necessary personal safety equipment (goggles, lab coat, etc.)

2- Select four flat work pieces and mark them with numbers “1” , “2”, “3” and “4”

3- Ask the technician to fix work piece number 1 on the work table of the vertical milling machine

4- Watch the technician loading the end-mill / surface-mill on the vertical milling machine

5- Record the setup values for the cutting operation (rotational speed (N), feed rate, depth of cut) in Table (2)

6- Ask the technician to remove the first work piece

7- Repeat steps 3 – 6 for work piece number 2 with the same feed rate and depth of cut but at a different cutting speed

8- Repeat steps 3 – 6 for work piece number 3 with the same feed rate and cutting speed but at a different depth of cut

9- Repeat steps 3 – 6 for work piece number 4 with the same cutting speed and depth of cut but at a different feed rate

10- Take the four specimens and measure there surface roughness using the surface profilometer and record your data in Table (2)

11- Plot the surface roughness against different machining parameters, comment on your results and write your own conclusions

Table (2): Cutting parameters and surface roughness

Work piece	**Cutting speed (mm / min)**	**Feed rate (mm/rev)**	**Depth of cut (mm)**	**Surface roughness (R_a)**	**Surface roughness (R_q)**
1					
2					
3					
4					