ME 338 (S3) Manufacturing Processes II

Group Assignment 1

Due Date: 21.09.2021 (11:59 pm)

1. A feed of 0.5 mm/rev and depth of cut of 6.5 mm in a turning operation on an aluminium alloy workpiece. The lathe's motor has a horsepower of 15kW and a mechanical efficiency of 90 %. The specific cutting energy of this aluminium grade is 180 J/ mm^3). What is the highest cutting speed that this job can handle?

2. Fifty 1 m diameter discs having an 80 mm diameter hole in the center are to be faced on a vertical boring machine with a feed of 0.25 mm/rev and a back engagement (depth of cut) of 5 mm. The machine has an automatic control device by which the cutting speed is continuously adjusted to allow maximum power utilization at the cutting tool of 3 kW. However the maximum rotational frequency of the spindle is limited to 42 rev/min. If the specific cutting energy for the work material is 2.27 GJ/m^3 and it takes 600 sec to unload a machined disc, load an un-machined disc and return the tool to the beginning of the cut. Calculate the total production time for the batch.

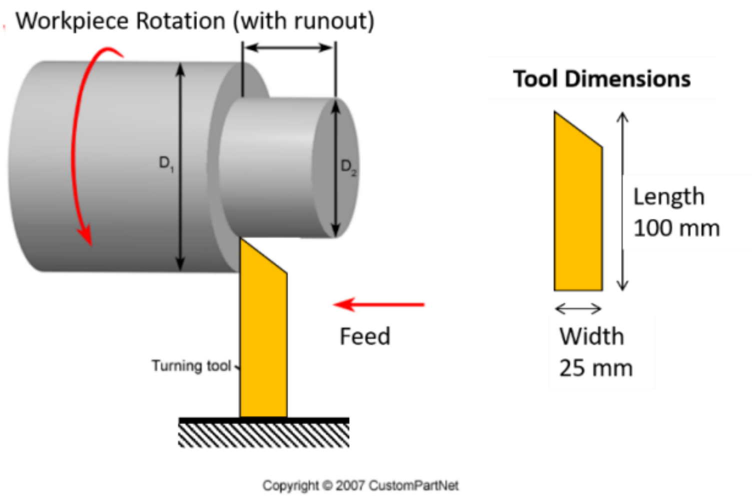
3. Steel is cut orthogonally with a 10° angle, a depth of cut of 2 mm, and a feed rate of 0.20 mm/rev. The cutting speed is 200 m/min. 0.31 is the chip thickness ratio. The vertical and horizontal components of dynamometer-measured forces are 1200N and 650N, respectively. Calculate the coefficient of friction, shear forces, and friction at the tool-chip interface. Also estimate the total power required. Note that total power is distributed in shear and friction domain.

4. Compare disposable and regrindable tooling. The same grade of cemented carbide tooling is available in two forms for turning operations in a certain machine shop: disposable inserts and brazed inserts. The parameters in the Taylor equation for this grade are: n = 0.25 and C = 300 (m/min) under the cutting conditions considered here. For the disposable inserts, price of each insert = \$6.00, there are four cutting edges per insert, and the tool change time = 1.0 min (this is an average

of the time to index the insert and the time to replace it when all edges have been used). For the brazed insert, the price of the tool = \$30.00 and it is estimated that it can be used a total of 15 times before it must be scrapped. The tool change time for the regrindable tooling = 3.0 min. The standard time to grind or regrind the cutting edge is 5.0 min, and the grinder is paid at a rate = \$20.00/hr. Machine time on the lathe costs \$24.00/hr. The workpart to be used in the comparison is 375 mm long and 62.5 mm in diameter, and it takes 2.0 min to load and unload the work. The feed = 0.30 mm/rev. For the two tooling cases, compare: (a) cutting speeds for minimum cost, (b) tool lives, (c) cycle time and cost per unit of production. Which tool would you recommend?

5. A drilling operation is performed in which 0.5 in diameter holes are drilled through cast iron plates that are 1.0 in thick. Sample holes have been drilled to determine the tool life at two cutting speeds. At 80 surface ft/min, the tool lasted for exactly 50 holes. At 120 surface ft/min, the tool lasted for exactly 5 holes. The feed rate of the drill was 0.003 in/rev. (Ignore effects of drill entrance and exit from the hole. Consider the depth of cut to be exactly 1.00 in, corresponding to the plate thickness.) Determine the values of n and C in the Taylor tool life equation for the above sample data, where cutting speed v is expressed in ft/min, and tool life T is expressed in min.

6. Turning operation is carried out using a solid HSS tool of dimensions 100 mm x 25 mm x 25 mm (See figure below). The workpiece rotates at 10 rev/s and has a runout due to which the tool experiences periodic thrust force with an amplitude of 1000 N. The tool material has density of 8000 kg/m^3 and elastic modulus of 200 GPa. Damping coefficient is 30 Ns/m.
   (a) What is the vibrational amplitude of the tool in the feed direction?
   (b) What rotational speed must be avoided to prevent the tool vibrations becoming unstable? State the required assumptions (if any) to solve the question.



7. In a slab-milling operation, the cutter has 10 teeth and is 100 mm in diameter. The rotational frequency of the cutter is 300 rev/min. The workpiece feed speed is 1.3 mm/sec, the depth of cut is 6 mm and the width of the workpiece is 50 mm. The relationship between the maximum undeformed chip thickness α_{cmax} in m and the specific cutting energy p_s in GJ/m^3 for the work material is

$$p_s = 1.4[1 + \frac{1.25 \times 10^{-6}}{a_{cmax}}]$$

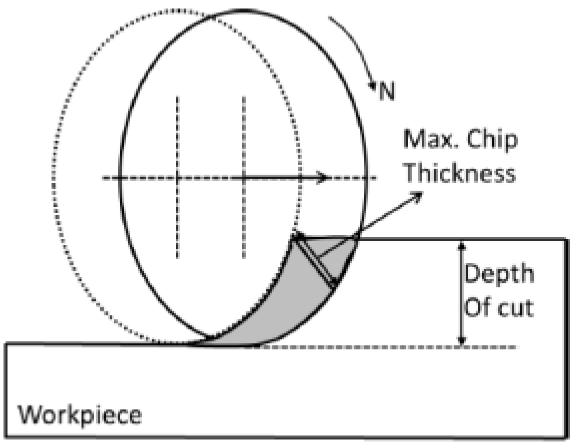


Figure 1. Schematic of slab-milling showing maximum chip thickness, a_{cmax}

a) Derive an expression for the maximum undeformed chip thinkness α_{cmax}

b) Estimate the maximum material removal rate in m^3 /sec.

c) What is the maximum power required in watts at the cutter?

8. A planing process is being used to machine a 300 mm x 300 mm x 25 mm flat mild steel block. The sharp single point cutting tool has a rake angle $\alpha = 10°$. (Note: Planing is an orthogonal cutting process) Other process parameters are as follows: Cutting Speed 2 m/s Undeformed chip thickness to 0.25 mm Deformed chip thickness tc 0.83 mm Width of cut per pass 2.5 mm. The cutting and thrust forces were measured during each pass with a cutting force dynamometer and found to be as follows: Fc = 890 N and Ft = 667 N.

(i). Calculate the percentage of total power dissipated in the primary zone of deformation (shear zone).

(ii). Calculate the mean temperature rise in the chip if it is given that the power dissipated into the workpiece per pass of the tool is 200 W.

Assume the density of mild steel is 7200 kg/m^3 and specific heat is 502 J $kg^{-1}K^{-1}$. Also assume that the cutting tool is insulated and no heat is lost to the environment.

9. A designer has specified a surface finish on turned shafts of 0.4-pm arithmetical mean when a surface finish of 1.6 pm would suffice. Estimate the cost of this mistake when 2000 shafts are to be produced with a tool with a rounded corner if the machining time per component = 600 s, the number of components produced between tool regrinds = 4, the cost of a sharp tool = \$2.00, the machine and operator rate = \$8/h, the tool-changing time = 120 s, and the non-productive time per component = 240 s