Advanced Machining Processes
Quiz 2

Name: Solution

1. **Briefly**, explain the two key reasons why empirical values obtained from room-temperature, quasi-static tensile tests are not very useful in cutting process analysis.

   a) Reason 1

Cutting occurs at very high temperature, as compared to room temperature. Increased temperature is known to strongly decrease yields strength / flow stress.

   b) Reason 2

Cutting occurs at very, very high strain rate, as compared to the usual strain rate seen in tensile tests (i.e., low strain rate). Increased strain rate is known to strongly increase yield strength / flow stress.

2. Cutting process analysis is based on a number of assumptions. One important one has to do with the stress-strain state in the shear zone and chip. What is this assumption?

We assume perfectly plastic behavior. This is a good assumption since, at the temperatures and strain rates typically seen in the cutting process, the stress-strain curves tend to be close to elastic – perfectly plastic. We then ignore the elastic deformation since the elastic strain is very small compared to the very high plastic strain seen in cutting.

3. Regarding 'specific energy' values:

   a) What does a specific energy value represent?

Power per unit volume per unit time.

   b) Despite the answer to (a), what are the **typical** SI-units for specific energy?

N / mm^2

   c) Explain with an equation how specific energy can be well related to h, V and rake angle γ_o?

$$u = e^{b_0} h^{b_h} V^{b_V} e^{b_\gamma \gamma_o}$$

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Quiz 2

4. Regarding energy/power in orthogonal cutting:

   a) What are the **two primary** energy/power **consumption** mechanisms?

Shearing power, $\mathscr{P}_s = P_\phi V_s$, and rake-face friction/shear power, $\mathscr{P}_f = P_\gamma V_c$.

   b) What is the input energy/power?

Cutting power, $\mathscr{P}_C = F_C V$.

   c) In **equation form**, what did Merchant's analysis verify with respect to these energies?

$u_C = u_s + u_f$, i.e., cutting energy/power = shearing energy/power + rake-face friction/shear power/energy

   d) What is the **easiest** (fewest calculations) way to calculate the cutting force given the uncut chip thickness h, uncut width (width of cut) w, cutting speed V, and specific cutting energy u_C?

$$F_C = u_C\, a = u_C\, (h\, w)$$

5. **Briefly**, explain what 'size effect' means in terms of total force and uncut chip thickness.

As h decreases, F decreases in an accelerating manner, i.e., u increases in an accelerating manner.