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First Semester 1447 H (Fall 2025) – 2(1,1,2)
"Introduction to Manufacturing"

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Milling Exercise + ANSWERS

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Material-Removal Rate and Cutting Time in Slab Milling

A slab-milling operation is being carried out on a $300-mm$-long, 100-mm-wide annealed mild-steel block at a feed f of 0.25 mm/tooth and a depth of cut $3.0\,mm$. The cutter is $D = 50\,mm$ in diameter, has 20 straight teeth, rotates at $100\,rpm$ and, by definition, is wider than the block to be machined. Calculate the following:

a) material-removal rate, MRR

b) cutting time, t

Given:

- Process: slab-milling
- Workpiece material: annealed mild-steel
- $l = 300\,mm$
- $w = 100\,mm$
- $f = 0.25\,mm/tooth$
- $d = 3.0\,mm$
- $D = 50\,mm$
- $n = 20$
- $N = 100\,rev/min$

Solution:

a) **material-removal rate**, $MRR = wdv$

$$f = \frac{v}{Nn}$$

$$\Rightarrow v = fNn = \left(0.25\,\frac{mm}{tooth}\right)\left(100\,\frac{rev}{min}\right)\left(20\,\frac{teeth}{rev}\right) = 500\ mm/min$$

$$\Rightarrow MRR = wdv = (100\ mm)(3.0\ mm)\left(500\,\frac{mm}{min}\right)\left(\frac{1\ min}{60\ s}\right)$$
$$= 2500\ mm^3/s$$

► $\boldsymbol{MRR = 2500\ mm^3/s}$

b) **cutting time**, t

$$t = \frac{l + l_c}{v}$$

For $D \gg d \Rightarrow l_c$ can be approximated using: $l_c = \sqrt{Dd}$

$$\Rightarrow l_c = \sqrt{Dd} = \sqrt{(50\ mm)\cdot(3\ mm)} = 12.247\ mm$$

$$\Rightarrow t = \frac{l + l_c}{v} = \frac{300\ mm + 12.247\ mm}{500\ mm/min} = 0.6245\ min$$

► $\boldsymbol{t = 37.5\ s}$

Note that if we did not do the above assumption for l_c

$$\Rightarrow l_c = \sqrt{d(D-d)} = \sqrt{(3.0\ mm)\cdot(50\ mm - 3.0\ mm)} = 11.873\ mm$$

$$\Rightarrow t = \frac{l + l_c}{v} = \frac{300\ mm + 11.873\ mm}{500\ mm/min} = 0.6237\ min$$

► $\boldsymbol{t = 37.4\ s}$

Thus the above assumption was justified.