

AGE-1320

Section 1, CRN: 320/321/378

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First Semester 1448 H (Fall 2026) – 2(1,1,2)

“Introduction to Manufacturing”

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Turning Exercise + **ANSWERS**

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Material-Removal Rate in Turning

A 150-mm-long, 12.5-mm-diameter 304 stainless steel rod is being reduced in diameter to 12.0 mm by turning on a lathe. The spindle rotates at $N = 400$ rpm, and the tool is travelling at an axial speed of 200 mm/min. Calculate the following:

- cutting speed
- material-removal rate
- cutting time

Given:

- Workpiece material: 304 stainless steel
- Turning on a lathe process
- $l = 150 \text{ mm}$
- $D_o = 12.5 \text{ mm}$
- $D_f = 12.0 \text{ mm}$
- $N = 400 \text{ rev/min}$
- $v = 200 \text{ mm/min}$ (note this is feed rate, NOT cutting speed, V)

Solution:

a) **cutting speed, $V = \pi D_{avg} N$**

$$D_{avg} = \frac{D_o + D_f}{2} = \frac{12.5 \text{ mm} + 12.0 \text{ mm}}{2} = 12.25 \text{ mm}$$

$$\Rightarrow V = \pi D_{avg} N = (\pi \text{ rad/rev})(12.25 \text{ mm})(400 \text{ rev/min}) \\ = 15393.80 \text{ mm/min}$$

► **$V = 15.4 \text{ m/min}$**

$$\text{Note, } V_{max} = \pi D_o N = (\pi \text{ rad/rev})(12.5 \text{ mm})(400 \text{ rev/min}) \\ = 15707.96 \text{ mm/min} = 15.7 \text{ m/min}$$

b) **material-removal rate, $MRR = dfV$**

$$\text{depth of cut, } d = \frac{D_o - D_f}{2} = \frac{12.5 \text{ mm} - 12.0 \text{ mm}}{2} = 0.25 \text{ mm}$$

$$\text{feed, } f = \frac{v}{N} = \frac{200 \text{ mm/min}}{400 \text{ rev/min}} = 0.50 \text{ mm/rev}$$

$$\Rightarrow MRR = dfV = (0.25 \text{ mm})(0.50 \text{ mm})(15393.80 \text{ mm/min}) \\ = 1924.2 \text{ mm}^3/\text{min}$$

► **$MRR = 1924 \text{ mm}^3/\text{min}$**

c) **cutting time, $t = \frac{l}{fN}$**

$$\text{length of cut, } l = 150 \text{ mm}$$

$$\Rightarrow t = \frac{l}{fN} = \frac{150 \text{ mm}}{(0.50 \text{ mm/rev})(400 \text{ rev/min})} = 0.75 \text{ min}$$

► **$t = 0.75 \text{ min} = 45.0 \text{ s}$**