1. A lathe is used to turn the diameter of an SAE 1040 steel work piece at 185 BHN from 2.40 inches to 1.50 inches. The cutting speed chosen is 120 (not to be exceeded), and the feed is 0.016. The length of the cut is 18.5 inches.

a. What are the most appropriate English units for the cutting speed?

1 PT

FEET PER MINUTE

b. What are the most appropriate English units for the feed?

1 PT

INCHES PER REVOLUTION

c. Assuming sufficient power, is it appropriate to make this depth of cut if it is a roughing cut? (Briefly justify your answer from the presented slides.)

$$d = \frac{D_0 - D_f}{2} = \frac{(2.40 - 1.50)\ \text{IN}}{2} = .45\ \text{IN}$$

4 PTS

SINCE $0.1\ \text{IN} \le 0.45\ \text{IN} \le 0.75\ \text{IN}$, YES IT IS APPROPRIATE

(REF. SLIDE 12, LECT. 04)

d. Calculate the cutting time required to make the cut, as specified.

8 PTS

4 PTS
$$N = \frac{V}{\pi D_0} = \frac{(120\ \text{FT/MIN})(12\ \text{IN/FT})}{\left(\frac{\pi}{\text{REV}}\right)(2.40\ \text{IN})} = 191\ \text{RPM}$$

2 PTS
$$f_R = Nf = \left(\frac{191\ \text{REV}}{\text{MIN}}\right)\left(\frac{0.016\ \text{IN}}{\text{REV}}\right) = 3.06\ \text{IN/MIN}$$

(DEDUCT 3 PTS IF UNITS WRONG)

2 PTS
$$T_M = \frac{L}{f_R} = \frac{18.5\ \text{IN}}{3.06\ \text{IN/MIN}} = 6.05\ \text{MIN}$$

e. Calculate the material removal rate for the cut, as specified.

5 PTS

$MRR = vfd$ (GROOVER/SME UNIT NOTE)

$$= \left(\frac{120\ \text{FT}}{\text{MIN}}\right)\left(\frac{12\ \text{IN}}{\text{FT}}\right)(0.016\ \text{IN})(0.45\ \text{IN})$$

$= 10.4\ \text{IN}^3/\text{MIN}$ (GROOVER/SME VALUE)

$MRR = \pi D_{AVG}\, d f N$ (KALPAKJIAN EQN)

$$= \pi\left(\frac{2.40\ \text{IN} + 1.50\ \text{IN}}{2}\right)(0.45\ \text{IN})\left(\frac{0.016\ \text{IN}}{\text{REV}}\right)\left(\frac{191\ \text{REV}}{\text{MIN}}\right)$$

$= 8.4\ \text{IN}^3/\text{MIN}$ (KALPAKJIAN/SDSMT VALUE)

f. If the unit power for carbon steel at 185 BHN is 240,000 in-lb/in^3, estimate the cutting force for the specified cut.

$$P_c = F_c v \Rightarrow F_c = \frac{P_c}{v} = \frac{P_u(MRR)}{v}$$

5 PTS

$$F_c = \frac{(240\,000\ \text{IN-LB/IN}^3)(10.4\ \text{IN}^3/\text{MIN})}{(120\ \text{FT/MIN})(12\ \text{IN/FT})}$$

$= 1733$ LBs (GROOVER/SME VALUE)

$$F_c = \frac{(240\,000\ \text{IN-LB/IN}^3)(8.4\ \text{IN}^3/\text{MIN})}{(120\ \text{FT/MIN})(12\ \text{IN/FT})}$$

$= 1400$ LBs (KALPAKJIAN/SDSMT VALUE)

2. A face milling operation is being performed on a brass piece with a 6 inch diameter, 10-toothed HSS cutter.

a. Using a feed of .025 in/tooth, and a cutting speed of 150, find the cutting time (to the nearest second) if the length of the cut is 7.0 inches, and the width of the cut is 2.5 inches.

(WRONG UNITS -3)

10 pts

4 pts
$$N = \frac{V}{\pi D} = \frac{(150\ FT/MIN)(12\ IN/FT)}{\pi (6\ IN)} = 95.5\ RPM$$

REV

3 pts
$$f_R = N n_t f = (95.5\ REV/MIN)(.025\ IN/TOOTH)(10\ TEETH/REV) = 23.875\ IN/MIN$$

3 pts
$$T_m = \frac{L + D}{f_R} = \frac{7.0\ IN + 6\ IN}{23.875\ IN/MIN} = 0.54\ MIN \text{ -OR- } \underline{32\ s}$$

b. Find the material removal rate for the cut in Question 2a if the depth of cut is 0.20 inches.

3 pts
$$MRR = w d f_R = (2.5\ IN)(0.20\ IN)(23.875\ IN/MIN) = \underline{11.94\ IN^3/MIN}$$

c. Assume that the unit horsepower for brass is 0.8 hp-min/in^3. Can this particular cut be made on a 5.5 hp mill if the tooling is new and the motor is 75% efficient?

GIVEN $HP_u = 0.8\ HP\text{-}MIN/IN^3$

IF CUT CAN BE MADE, THEN $HP_G(E) \geq HP_C \geq HP_u(MRR)$

5 pts
$$\Rightarrow HP_G(E) \overset{?}{\geq} HP_u(MRR)$$

$$\Rightarrow (5.5\ HP)(.75) \overset{?}{\geq} (0.8\ HP\text{-}MIN/IN^3)(11.94\ IN^3/MIN)$$

$\Rightarrow$ IS $4.13\ HP \geq 9.55\ HP$? $\Rightarrow$ <u>NO</u> THE CUT CANNOT BE MADE AS SPECIFIED

18 pts Total

3. A fixture is being considered to improve a manufacturing process (see current rate information, below). If it is implemented, it will reduce the cycle time by 10.8 s to 43.2 s/part. It will also allow a 4.8% reduction from the current operator cost as less trained labor will be required, and it will allow the use of older machines that have already been depreciated – saving 19.20% off of the current machine rate. If the current MARR is 12% APR, compounded monthly, what is the maximum that can be spent to construct the tooling if it must meet a 2 year payback?

Current Rates:
R = Labor Rate: $18.75/hr
R_M = Machine Rate: $8.04/hr
N = Production Req'd: 640 pieces/yr

3 pts $R_t = \$18.75/\text{HR}(1-.048) = \$17.85/\text{HR}$

3 pts $R_{mt} = \$8.04/\text{HR}(1-.192) = \$6.50/\text{HR}$

3 pts $t = \frac{43.2s+10.8s}{\text{PC}} = (54s/\text{PC})\left(\frac{1\text{ HR}}{3600s}\right) = 0.015 \text{ HR/PC}$

3 pts $t_t = (43.2s/\text{PC})\left(\frac{1\text{ HR}}{3600s}\right) = 0.012 \text{ HR/PC}$

3 pts $i = \frac{R}{M} = \frac{.12/\text{YR}}{12\text{ MO/YR}} = .01/\text{MO}$

3 pts $n = (2\text{ YR})(12\text{ MO/YR}) = 24\text{ MO}$

$$(R+R_m)t - (R_t+R_{mt})t_t \geq \frac{C_t}{N}\left[\frac{i(1+i)^n}{(1+i)^n-1}\right]$$

$$\Rightarrow C_t = \frac{N\left[(R+R_m)t-(R_t+R_{mt})t_t\right]}{\left[\frac{i(1+i)^n}{(1+i)^n-1}\right]}$$

3 pts
$$= \frac{(2\text{ YRS})(640\text{ PC/YR})\left[(\$18.75/\text{HR}+\$8.04/\text{HR})(.015\text{ HR/PC})-(\$17.85/\text{HR}+\$6.50/\text{HR})(.012\text{ HR/PC})\right]}{\left[\frac{.01(1+.01)^{24}}{(1+.01)^{24}-1}\right]}$$

$$= \frac{\$140.352}{0.04707}$$

1 pt
$$= \$2982$$

24 pts TOTAL