PART B: TECHNOLOGY DESIGN PROBLEM (20 Marks)

Q21) The thickness of a slab of 100x250mm is reduced by 16mm with an end milling cutter of 75mm diameter with 10 teeth. The maximum allowed cutting speed and depth of cut are 20m/min and 4mm, respectively. The maximum feed per tooth is 0.25mm. Consider no cutting allowance, select the proper direction of cutting so that the actual MRR is high. The specific power of the workpiece is 1.3 Ws/mm^3, and the mechanical efficiency is 75 %. The machining cost is 100$/hour.

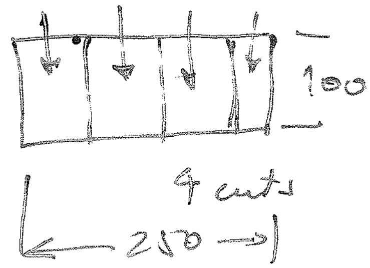
Find out the following: (BE CAREFUL ABOUT UNITS.)

a) Identify the direction of cutting with respect to the job dimensions. Sketch the tool path. (4 Marks)
b) The maximum possible width of the cut, in 'mm'. (2 Marks)
c) The maximum rpm of the cutter (2 Marks)
d) The maximum feed per minute, in 'mm/min'. (2 Marks)
e) The total cutting time, in 'min'. (2 Marks)
f) The maximum MRR, in 'mm^3/min'. (2 Marks)
g) The actual MRR, in 'mm^3/min'. (2 Marks)
h) The motor power required, in Watts. (2 Marks)
i) The total machining cost, in $. (2 Marks)

$L := 250$ mm $\quad A := 16$ mm $\quad v := 20000$ mm/min $\quad HPs := 1.3$ W s/mm^3

$W := 100$ mm $\quad t := 4$ mm $\quad ft := 0.25$ mm/tooth $\quad \eta := 0.75$

$D := 75$ mm $\quad n := 10 \quad r := \frac{D}{2} \quad price := 100$ \$/hour (1)



Assuem no allowance at all (not even the radius of the end-mill tool)
cutting along the L direction requires two cuts of 250 mm each, this si 500 mm
cutting along the width W requires 4 passes of 100 mm each
Duration of cutting at the same cutting conditions will be shorter for the second orientation case and therefore the MRR will be higher for shorter cutting time when the volume of material si same

$V := L \cdot W \cdot t \qquad V = 1 \times 10^5$ mm^3

$frev := ft \cdot n$

(2) max width of cut is given by the toof size, this is D=75mm ✓

$RPM := \frac{v}{r \cdot 2 \cdot \pi}$ (3) $RPM = 84.883$ rev/min

$fmin := frev \cdot RPM$ (4) $fmin = 212.207$ mm/min

$CT1 := \frac{2 \cdot L}{fmin}$

$CT2 := 4 \cdot \frac{W}{fmin}$

$CT1 = 2.356 \qquad CT1 = 2.356$

$CT2 = 1.885$ (5) $CT2 = 1.885$ min

(6) $MRR_{max} = 6.366 \times 10^4$

$MRR1 := \frac{V}{CT1} \qquad MRR1 = 4.244 \times 10^4$

$MRR2 := \frac{V}{CT2}$ (7) $MRR2 = 5.305 \times 10^4$ mm^3/min

$HP := \frac{HPs \cdot MRR2}{\eta}$ (8) $HP = 9.196 \times 10^4$

need 4 cuts of the minimum cutting time to achieve the task

$MT := \frac{CT2 \cdot 4}{60}$

$COST := MT \cdot price$ (9) $COST = 12.566$