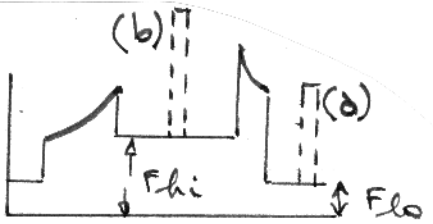
5 Addition of the idler pulley gives a third peak in the equivalent force diagram (see pg. 6 of notes).



If the pulleys rotate clockwise then the idler is located on the slack side (a).
If the pulleys rotate anticlockwise then the idler is on the tight side (b).
Since the idler's diameter is small, its peak on the diagram will be large.
Since there are three peaks per cycle, the code approach cannot be used. The head-up to equation (5a) of Notes was to be amended to consider three terms in Miner's rule.
The small diameter pulley (1) will limit, so

$k_\theta = 1 - e^{-f\theta} = 1 - \exp\left(-0.512 \times 118 \frac{\pi}{180}\right) = 0.652$

$v = \pi d n = \pi \times 0.150 \times 2880/60 = 22.6$ m/s

(5a) $\hat{F} = P/k_\theta v z + p v^2 = 10^4/0.652 \times 22.6 \times 2 + 0.09682 \times 22.6^2 = 389$ N

(5) $\check{F} = \hat{F} - P/vz = 389 - 10^4/22.6 \times 2 = 168$ N

(a) The three peaks are:

$F_1 = \hat{F} + M/d_1 = 389 + 23.93/0.15 = 548$ N

$F_2 = \hat{F} + M/d_2 = 389 + 23.93/0.4 = 449$ N

$F_3 = \check{F} + M/d_3 = 168 + 23.93/0.08 = 467$ N

So equation (5a) becomes:-

$548^m + 449^m + 467^m = F^m (L/vT)$; $F = 3216$ N

where $L/vT = 3.706 \times 10^{-9}$

so $T = 1.75/3.706 \times 10^{-9} \times 22.6 = 21$ Ms $= \underline{5.8}$ khr

(b) The idler peak is superimposed on tight side $\hat{F}$:

$F_3 = \hat{F} + M/d_3 = 389 + 23.93/0.08 = 688$ N

$\therefore L/vT = (548/3216)^m + (449/3216)^m + (688/3216)^m = 3.929 \times 10^{-8}$

$T = 1.75/3.929 \times 10^{-8} \times 22.6 = 1.97$ Ms $= \underline{0.55}$ khr

(c) If the idler is absent $c = 425$ mm

$k_\theta = 1 - \exp(-f\theta) = 1 - \exp\left(-0.512\left(\pi - 2\sin^{-1}\frac{400-150}{2\times 425}\right)\right) = 0.728$

so $P/k_\theta vz = 10^4/0.728 \times 22.6 \times 2 = 304$ N

and equation (5a) takes the values:-

$L/vT = [(304 + 23.93/0.15 + 0.09682 \times 22.6^2)/3216]^m + [(304 + 23.93/0.4 + 0.09682 \times 22.6^2)/3216]^m$

$= 1.502 \times 10^{-9}$

$\therefore T = 1.75/1.502 \times 10^{-9} \times 22.6 = 51.5$ Ms $= \underline{14}$ khr