20 Use shaft design equation corresponding to either MSS (max shear stress) or DE (distortion energy) since material is ductile

First find the two belt tensions and torque through shaft from pulley A to pinion C.

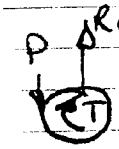
$\omega = 2\pi \times 7.5 = 47.1$ rad/s

$T = P/\omega = 20\times10^3/47.1 = 424$ Nm.

$\Delta = (F_1 - F_2).r = (4F_2 - F_2).r$ here

$\therefore F_2 = 424/(4-1)\times 0.125 = 1132$ N

so $F_1 = 4F_2 = 4527$ N.



The pinion reaction is

$P = T/r = 424/0.075 = 5659$ N.

Can now consider loads on shaft

In the vertical plane, P is central load in span BCD

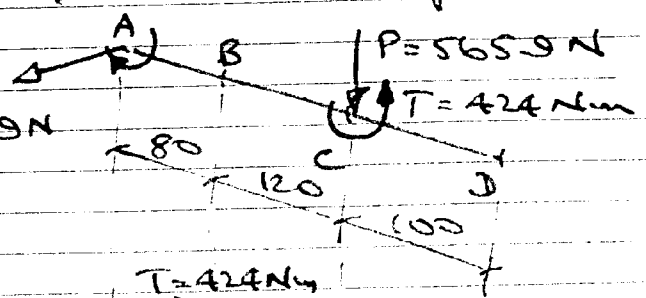
$\therefore R_{DV} = 5659 \times \frac{120}{120+100}$

$= 3087$ N

$\therefore M_{CV} = R_{DV} \times CD$

$= 3087 \times 0.1$

$= 309$ Nm

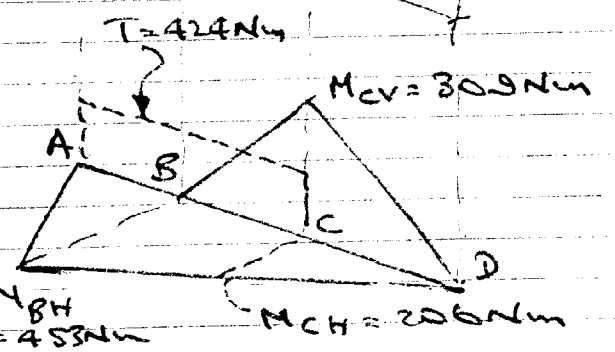


In the horizontal plane

$M_{BH} = (F_1+F_2) \times AB$

$= 5659 \times 0.08$

$= 453$ Nm



& $M_{CH} = \frac{100}{100+120} \times 453 = 206$ Nm by proportion

consider only points B & C for which info. given

			B	C
M_H	Nm		453	206
M_V	Nm		0	309
T	Nm		424	424
D	mm		60	55
EITHER MSS		$M_e = \sqrt{(M_H^2 + M_V^2 + T^2)}$	621	564
		$n = \pi D^3 S/32 M_e$	17.1	14.5 = n shaft.
OR DE		$M_e = \sqrt{(M_H^2 + M_V^2 + \frac{3}{4}T^2)}$	583	522
		$n = \pi D^3 S/32 M_e$	18.2	15.6 = n shaft

Note how DE is less conservative than MSS