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(* Problem 12 *)
Apply[Clear,Names["Global`*"]];
Off[General::spell];
Off[General::spell1];

n=300; (* rotational speed [rpm] *)
FP={0,-200,500}; (* [N] *)
FR={0,-600,-1500}; (* [N] *)
FA={0,FAy,FAz};
FB={0,FBy,FBz};
r1=0.15; (* [m] *)
r2=0.05; (* [m] *)
l=0.025; (* [m] *)
s=0.1; (* [m] *)

" $\sum M_A = r_{AB} \times FB + r_{AP} \times FP + r_{AR} \times FR = 0 \Rightarrow$ "
rAB={s,0,0};
rAO={-l,0,0};
rOP={0,r1,0};
rAP=rAO+rOP;
rAQ={s+l,0,0};
rQR={0,r2,0};
rAR=rAQ+rQR;
MA=Cross[rAB,FB]+Cross[rAP,FP]+Cross[rAR,FR];
sB=Solve[{MA[[2]]==0,MA[[3]]==0},{FBy,FBz}];
By=FBy/.sB[[1]];
Bz=FBz/.sB[[1]];
Print["FBy = ",By," N"];
Print["FBz = ",Bz," N"];
B=Sqrt[By^2+Bz^2];
Print["|FB| = (FBy^2 + FBz^2)^0.5 = ",B," N"];

" $\sum F = 0 \Rightarrow FA = -FB -FP -FR$ "
fA=-{0,By,Bz}-FP-FR;
Ay=fA[[2]];
Az=fA[[3]];
Print["FAy = ",Ay," N"];
Print["FAz = ",Az," N"];
A=Sqrt[Ay^2+Az^2];
Print["|FA| = (FAy^2 + FAz^2)^0.5 = ",A," N"];
"selection is based on greater force "
If[A>B,F=A,F=B];
Print["bearing radial force F = ",F," N"];
"design life DL = 30 000 h (Table 4)"
DL=30000; (* h *)
L=n DL 60;
Print["life L = n DL 60 = ",L," rev "];
"application factor Ka = 1.1 for gearing (Table 3)"
Ka = 1.1;
Kr = 1;
LR=90 10^6;
"LR = 90 x 10^6; Kr = 1"
"Creq = Ka F (L/LR)^0.3"
Creq = Ka F (L/LR)^0.3;
Print["rated capacity Creq = ",Creq," N"];
"from Table 2 with 3.9 kN and L00 series => C=4.2 kN and d=35 mm bore"
"from Table 1 with d=35 mm bore and L00 series => L07 bearing number"

 $\sum M_A = r_{AB} \times FB + r_{AP} \times FP + r_{AR} \times FR = 0 \Rightarrow$ 

FBy = 700. N

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$$F_{Bz} = 2000. \text{ N}$$

$$|F_B| = (F_{By}^2 + F_{Bz}^2)^{0.5} = 2118.96 \text{ N}$$

$$\sum F = 0 \Rightarrow F_A = -F_B -F_P -F_R$$

$$F_{Ay} = 100. \text{ N}$$

$$F_{Az} = -1000. \text{ N}$$

$$|F_A| = (F_{Ay}^2 + F_{Az}^2)^{0.5} = 1004.99 \text{ N}$$

selection is based on greater force

bearing radial force  $F = 2118.96 \text{ N}$

design life  $DL = 30\,000 \text{ h}$  (Table 4)

life  $L = n \text{ DL } 60 = 540000000 \text{ rev}$

application factor  $K_a = 1.1$  for gearing (Table 3)

$$LR = 90 \times 10^6; K_r = 1$$

$$C_{req} = K_a F (L/LR)^{0.3}$$

rated capacity  $C_{req} = 3989.89 \text{ N}$

from Table 2 with  $3.9 \text{ kN}$  and L00 series  $\Rightarrow C=4.2 \text{ kN}$  and  $d=35 \text{ mm}$  bore

from Table 1 with  $d=35 \text{ mm}$  bore and L00 series  $\Rightarrow$  L07 bearing number