U3 Position of engine c.g. (given) $= \begin{pmatrix} 5 \\ -1 \\ -1 \end{pmatrix}$ M

Weight of engine (given) $= \begin{pmatrix} 0 \\ 0 \\ -50 \end{pmatrix}$ KN

a) Moment about origin $\underline{M} = \underline{r} \times \underline{F} = \begin{pmatrix} 5 \\ -1 \\ -1 \end{pmatrix} \times \begin{pmatrix} 0 \\ 0 \\ -50 \end{pmatrix}$

$$\underline{M} = \begin{pmatrix} +50 \\ +250 \\ 0 \end{pmatrix} \text{ KNm} \Leftarrow$$

b) line OT $\Rightarrow \underline{t} = \begin{pmatrix} 30 \\ -14 \\ 2 \end{pmatrix}$ (given) unit vector $\hat{\underline{t}} = \frac{1}{\sqrt{1100}} \begin{pmatrix} 30 \\ -14 \\ 2 \end{pmatrix}$

use scalar product to project $\underline{M}$ onto $\hat{\underline{t}}$

$$\underline{M}_t = (\underline{M} \cdot \hat{t})\,\hat{t} = \frac{1}{\sqrt{1100}} \underbrace{(50 \times 30 + (250 \times (-14)) + 0)}_{(1500 + (-3500)) = -2000} \left[\frac{1}{\sqrt{1100}} \begin{pmatrix} 30 \\ -14 \\ 2 \end{pmatrix} \right]$$

$\hat{t}$

$$= -\frac{2000}{1100} \begin{pmatrix} 30 \\ -14 \\ 2 \end{pmatrix} = \begin{pmatrix} -54.5 \\ +25.5 \\ -3.6 \end{pmatrix} \text{ KNm} \Leftarrow .$$

This causes twisting of the wing about its axis.

c) $M_{\perp} = M - M_{parallel}$

$$\begin{pmatrix} 50 \\ 250 \\ 0 \end{pmatrix} - \begin{pmatrix} -54.5 \\ 25.5 \\ -3.6 \end{pmatrix} = \begin{pmatrix} 104.5 \\ 224.5 \\ +3.6 \end{pmatrix} \text{ kNm} \Subset$$

check

$$\begin{pmatrix} 104.5 \\ 224.5 \\ 3.6 \end{pmatrix} \cdot \begin{pmatrix} 30 \\ -14 \\ 2 \end{pmatrix} = 0 \Subset$$

(d) This component of the moment causes bending of the wing about its axis. $\Subset$

d) See answers to parts (b) and (c).