SNS COLLEGE OF ENGINEERING<br>Kurumbapalayam (Po), Coimbatore - 641107<br>Accredited by NAAC-UGC with 'A' Grade<br>Approved by AICTE \& Affiliated to Anna University, Chennai

Problem 6:

A uniform laddu of weight 1000 N and of length 4 m rests on a horizontal ground and leans against a smooth wall. The ladder makes an angle of $60^{\circ}$ with horizontal. When a man of weight 750 N stands on the ladder at a distance 3 m from the top of the ladder, the ladder is at the point of sliding. Determine the coefficient of friction between the ladder and the floor.


Applying $\sum H=0$

$$
\begin{gathered}
\mathrm{N}_{\mathrm{B}}-\mathrm{F}_{\mathrm{A}}=0 \\
\mathrm{~N}_{\mathrm{B}}-\mu \mathrm{N}_{\mathrm{A}}=0 \\
\mathrm{~N}_{\mathrm{B}}=\mu_{\mathrm{A}} \times \mathrm{N}_{\mathrm{A}}
\end{gathered}
$$

Applying $\sum V=0$

$$
\begin{gathered}
\mathrm{N}_{\mathrm{A}}-1000-750=0 \\
\therefore \mathrm{~N}_{\mathrm{A}}=1750 \mathrm{~N} \\
\mathrm{~N}_{\mathrm{B}}=\mu_{\mathrm{A}} \times 1750 \rightarrow(1)
\end{gathered}
$$

Taking the moments of all forces about A and equating to zero.
Applying $\sum m_{A}=0(\downarrow+)$

$$
\left(\mathrm{N}_{\mathrm{B}} \times \mathrm{BG}\right)-(1000 \times \mathrm{AF})-(750 \times \mathrm{AE})=0
$$

SNS COLLEGE OF ENGINEERING
Kurumbapalayam (Po), Coimbatore - 641107
Accredited by NAAC-UGC with 'A' Grade
Approved by AICTE \& Affiliated to Anna University, Chennai

From the geometry of the Figure

$$
\begin{gathered}
B G=4 \sin 60=3.464 m ; A F=2 \cos 60=1 m \\
A E=1 \cos 60=0.5 \mathrm{~m} \\
\therefore\left(\mathrm{~N}_{\mathrm{B}} \times 3.464\right)-(1000 \times 1)-(750 \times 0.5)=0 \\
\mathrm{~N}_{\mathrm{B}}=396.9 \mathrm{~N}
\end{gathered}
$$

Substitute $\mathrm{N}_{\mathrm{B}}$ in (1)

$$
\begin{gathered}
\mathrm{N}_{\mathrm{B}}=\mu_{\mathrm{A}} \times 1750 \\
396.9=\mu_{\mathrm{A}} \times 1750 \\
\mu_{\mathrm{A}}=0.226
\end{gathered}
$$

## Problem 7:

A 7 m long ladder rests against a vertical wall, with which it makes an angle of $45^{\circ}$ and on a floor. If a man whose weight is one half that of the ladder climbs it at what distance along the ladder will he be, when the ladder is about to slip? Take coefficient of friction between the ladder and the wall is $\frac{1}{3}$ and that between the ladder and the floor is $1 / 2$.

SNS COLLEGE OF ENGINEERING
Kurumbapalayam (Po), Coimbatore - 641107
Accredited by NAAC-UGC with 'A' Grade
Approved by AICTE \& Affiliated to Anna University, Chennai


Applying $\sum H=0(\rightarrow+)$

$$
\begin{gathered}
F_{A}-N_{B}=0 \\
\frac{1}{2} N_{A}-N_{B}=0 \\
N_{A}=2 N_{B} \rightarrow(1)
\end{gathered}
$$

Applying $\sum V=0(\uparrow+)$

$$
\begin{aligned}
& N_{A}+F_{B}-W-\frac{W}{2}=0 \\
& N_{A}+\frac{1}{3} N_{B}-\frac{3}{2} W=0
\end{aligned}
$$

Sub $N_{A}$

$$
\begin{gathered}
2 N_{B}+\frac{1}{3} N_{B}-\frac{3}{2} W=0 \\
2 N_{B}+\frac{1}{3} N_{B}=\frac{3}{2} W \\
\frac{6 N_{B}+N_{B}}{3}=\frac{3}{2} W \\
\frac{7 N_{B}}{3}=\frac{3}{2} W \\
N_{B}=\frac{9}{14} W \\
\therefore N_{A}=2 N_{B}=\frac{9}{7} W
\end{gathered}
$$

Taking moment about A and equating to zero

$$
\begin{gathered}
\sum m_{A}=0(\downarrow+) \\
(W \times A E)+\left(\frac{W}{2} \times A D\right)-\left(F_{B} \times A_{C}\right)-\left(N_{B} \times B C\right)=0
\end{gathered}
$$

From the geometry of the Figure,

$$
\begin{gathered}
A E=3.5 \cos 45^{\circ}=2.474 \mathrm{~m} \\
A D=x \cos 45^{\circ}=0.707 x \mathrm{~m} \\
A C=7 \cos 45^{\circ}=4.95 \mathrm{~m} \\
B C=7 \sin 45^{\circ}=4.95 \mathrm{~m} \\
(W \times 2.474)+\left(\frac{W}{2} \times 0.707 x\right)-\left(\frac{N_{B}}{3} \times 4.95\right)-\left(N_{B} \times 4.95\right)=0
\end{gathered}
$$

Sub $N_{B}=\frac{9}{14} W$,

## SNS COLLEGE OF ENGINEERING

Kurumbapalayam (Po), Coimbatore - 641107
Accredited by NAAC-UGC with 'A' Grade
Approved by AICTE \& Affiliated to Anna University, Chennai

$$
(W \times 2.474)+\left(\frac{W}{2} \times 0.707 x\right)-\left(\frac{9}{14} W \times \frac{1}{3} \times 4.95\right)-\left(\frac{9}{4} W \times 4.95\right)=0
$$

Solving we get

$$
{ }^{5}{ }^{5}
$$

