UNIVERSITY OF NAIROBI
DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING
FME 211/212 – THEORY OF MACHINES LABORATORY EXPERIMENT

TITLE: Belt Friction

OBJECT:

To determine the coefficient of friction between belt and pulley and to check the effect of lap angle on the grip of the belt

APPARATUS:

See Fig. I. The belt friction rig consists of a pulley *A* free to rotate about the spindle *B*. The arm C can be adjusted to give various lap angles to the belt under test.
The belt *D* is connected to the spring balance *E* attached to the arm **C**. A weight carrier is hung on the other end of the belt, which hangs over the pulley wheel.

METHOD:

Arm C is set to the required Lap Angle and a weight added to the weight carrier *(T2)*.The pulley wheel is then twisted by hand in the direction that will increase the reading on the spring balance *(T1)*. The *static friction coefficient* can be determined from the value of *(T1)* just before the ***belt slips***. Further weights should be added to the carrier until the spring balance reads approximately **25 kgf**. Weights should then be removed from the carrier so as to give 5-7 equally space reading between 0 and 25 kgf for T1.

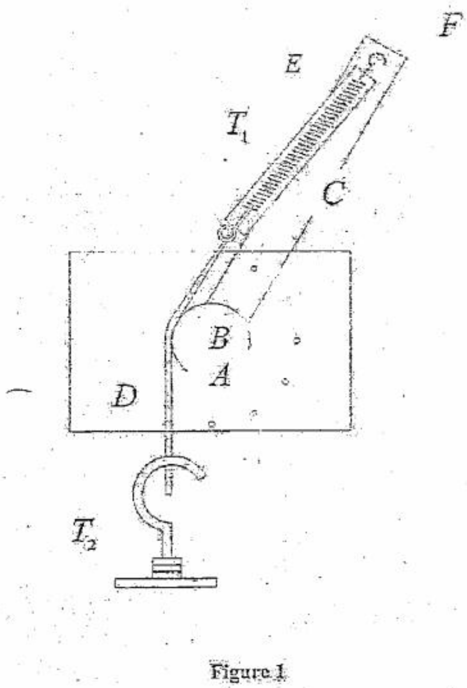

Figure 1

*(*For your calculations 1lbf=4.45 N)*

THEORY:

A flat belt is wrapped round a segment of a flat pulley. The limiting tensions in the two ends of the belt are TI and *T2*

Refer Fig 3

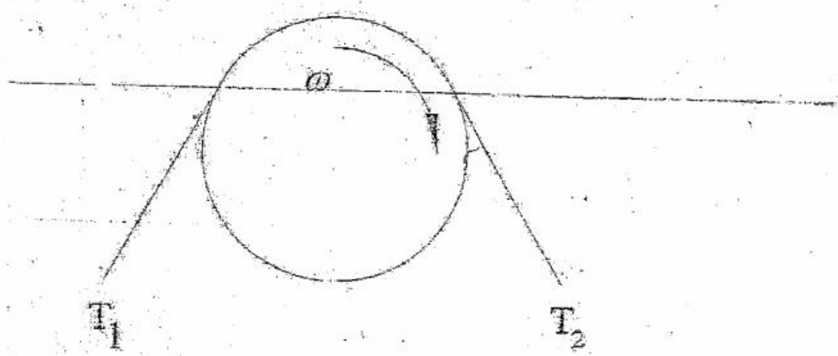

Figure 2.

Consider a small arc of the pulley ∂. The tension on one side will be ***T*** and the other side ***T+∂ T.***

Let the radial reaction ***Cl,*** the element of the belt be ***R.*** Then for the limiting case, the frictional force = R.

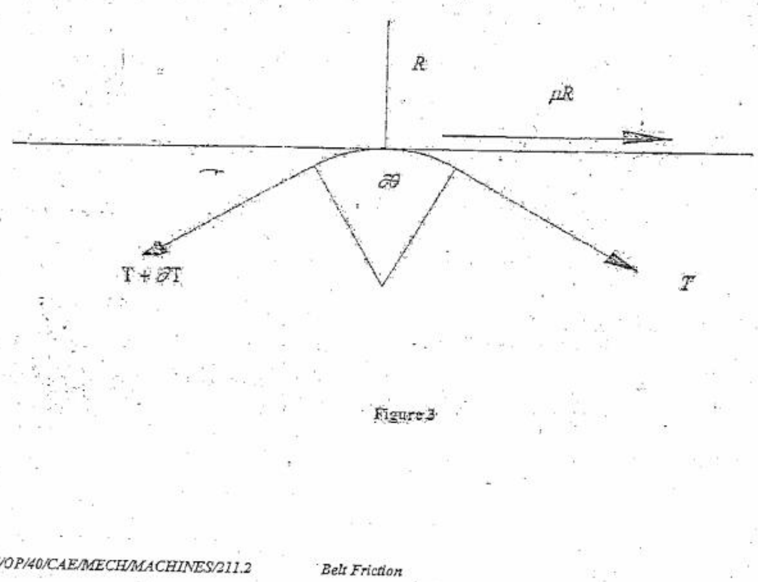

Figure 3

Resolving forces radially, $R = (T + \partial T)\sin\frac{\partial\theta}{2} + T\sin\frac{\partial\theta}{2}$

Neglecting 2[nd] order of small quantities, and writing $Sin\,\partial\theta = \partial\theta$, *then*

$R = T\,\partial\theta$ .... (i)

Then resolving forces tangentially, $\partial T = R$ ...... (ii)

From (i) and (ii) $\partial T = T\,\partial\theta$

Or $\frac{\partial T}{T} = \alpha\partial\theta$

Integrating,

$$\int_{T2}^{T1}\frac{\alpha T}{T} = \mu\partial\theta$$

i.e. $T_1 = \mu\theta$ ....(iii)

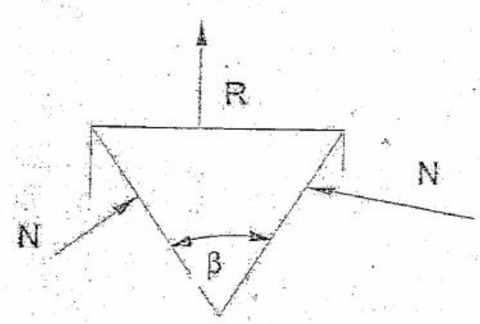

Figure 4

Note that this equation holds only when a slip is impending.

Refer to Fig IV above.

For a vee-belt the normal reaction between belt and pulley = N

$\therefore R = 2N\,cosec\left(\frac{\beta}{2}\right)$, where β is vee or groove angle.

Then for the limiting case,
Frictional force = $2\mu N$

$$\mu R \operatorname{cosec} \frac{\beta}{2} \qquad \text{............... (iv)}$$

$$\partial T = \mu R \operatorname{cosec}\left(\frac{\beta}{2}\right) \qquad \text{....... (v)}$$

Equation (v), in conjunction with **equation,** (i) which still holds, finally yields, on integration

$$\frac{T_1}{T_2} = e^{\mu\beta} \operatorname{cosec} \frac{\beta}{2} \qquad \text{...... (v)}$$

EXPERIMENTAL RESULTS

Graphs of ***T1*** against ***T2*** should be obtained for lap angles of ***30, 90, 135*** **and 180** each curve consisting of **5-7 equally spaced points** to give values of ***T2*** between **0-25 kgf.**

From the best straight line of the points, the ration $\frac{T_1}{T_2}$ is found, and the value for μ calculated.

CONCLUSIONS

Comment on the accuracy of your results and give your ideas as to why there should be any variation in the value of μ as found at the different lap angles,