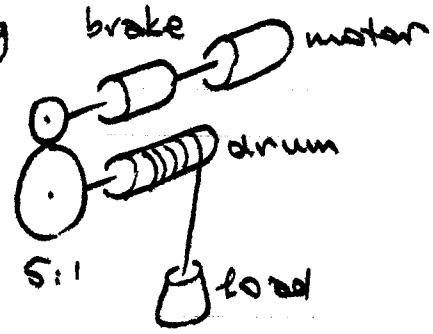
1 Assume stopping in range 59-60m
∴ Total load = $10^3 + 59.5 \times 0.5 = 1030$ kg
Take steel density 7.8 t/m³.
Take PE datum at 60m level.
$I_{drum} = 120 \times 0.11^2 = 1.45$ kg m²
$m_{wheel} = \pi \times 0.36 \times 0.05 \times 0.016 \times 7.8 \times 10^3$
$= 7.06$ kg
$\therefore I_{wheel} = 7.06 \left(\frac{0.36}{2}\right)^2 = 0.23$ kg m²



When the rope speed is 3 m/s, $\omega_{drum} = 3/\left(\frac{0.25}{2}\right) = 24$ rad/s
$\therefore \omega_{motor} = 5\,\omega_{drum} = 120$ rad/s
The initial energy of the system is:

PE load = $Wh = 1030 \times 9.81 \times 1$	=	10.10	kNm
KE load = $\frac{1}{2}mv^2 = \frac{1}{2} \times 1030 \times 3^2$	=	4.64	"
KE drum shaft = $\frac{1}{2}I\omega^2 = \frac{1}{2}(1.45 + 0.23) \times 24^2$	=	0.48	"
KE motor shaft = $\frac{1}{2}I\omega^2 = \frac{1}{2} \times 0.3 \times 12.0^2$	=	2.16	"
∴ work done by brake ($\theta_{final} = 0$), V	=	17.38	"

Rotation of brake (i.e. motor shaft) = $5 \times \frac{\Delta s}{r} = 5 \times \frac{1}{0.125} = 40$ rad
& $\bar{\omega} = \omega_0/2 = 60$ rad/s $= \Delta\theta/\Delta t$ ∴ $\Delta t = 40/60 = 2/3$ sec
∴ Brake torque = $V/\Delta\theta = 17.38 \times 10^3/40 = 435$ Nm
& mean power = $V/\Delta t = 17.38 \times 10^3/\frac{2}{3} = 26.1$ kW

2. $T_0 = \Sigma T = \Sigma \eta M = \Sigma \eta (\lambda P_0)$ from (12) $= P_0 \Sigma \lambda \eta$
∴ $\eta_0 = T_0/P_0 = \Sigma \lambda \eta$ Q.E.D.
From (vii)
$S_0 = \frac{\mu}{T_0} \frac{\partial T_0}{\partial \mu}\Big|_{P_0}$ where, from above, $T_0 = P_0 \Sigma \lambda \eta$.
$= \frac{\mu}{T_0} P_0 \Sigma \lambda \frac{d\eta}{d\mu} = \frac{\mu P_0}{T_0} \Sigma \lambda \frac{m\eta^2}{\mu}$ (since $\eta = \sqrt{k/\mu - d\Omega n}$)
– promised geometrically simpler shape.
$= m \Sigma \lambda \eta^2 / \Sigma \lambda \eta = \Sigma \lambda \eta S / \eta_0$ using (8) Q.E.D.

3, 4, 5, 6 The solutions to these follow along the lines of the worked example in the notes. The output of program 'Brakes' is shown overleaf. Special points to note are as follows.

3. Straightforward – actuation force and width are given – no scaling should be necessary. Rotation sense is immaterial, since asymmetric.
4. This is a most unusual brake. The top shoe is a mirror image of the lower two shoes, so results can be gotten

cont'd pg 3